JULY • 1955

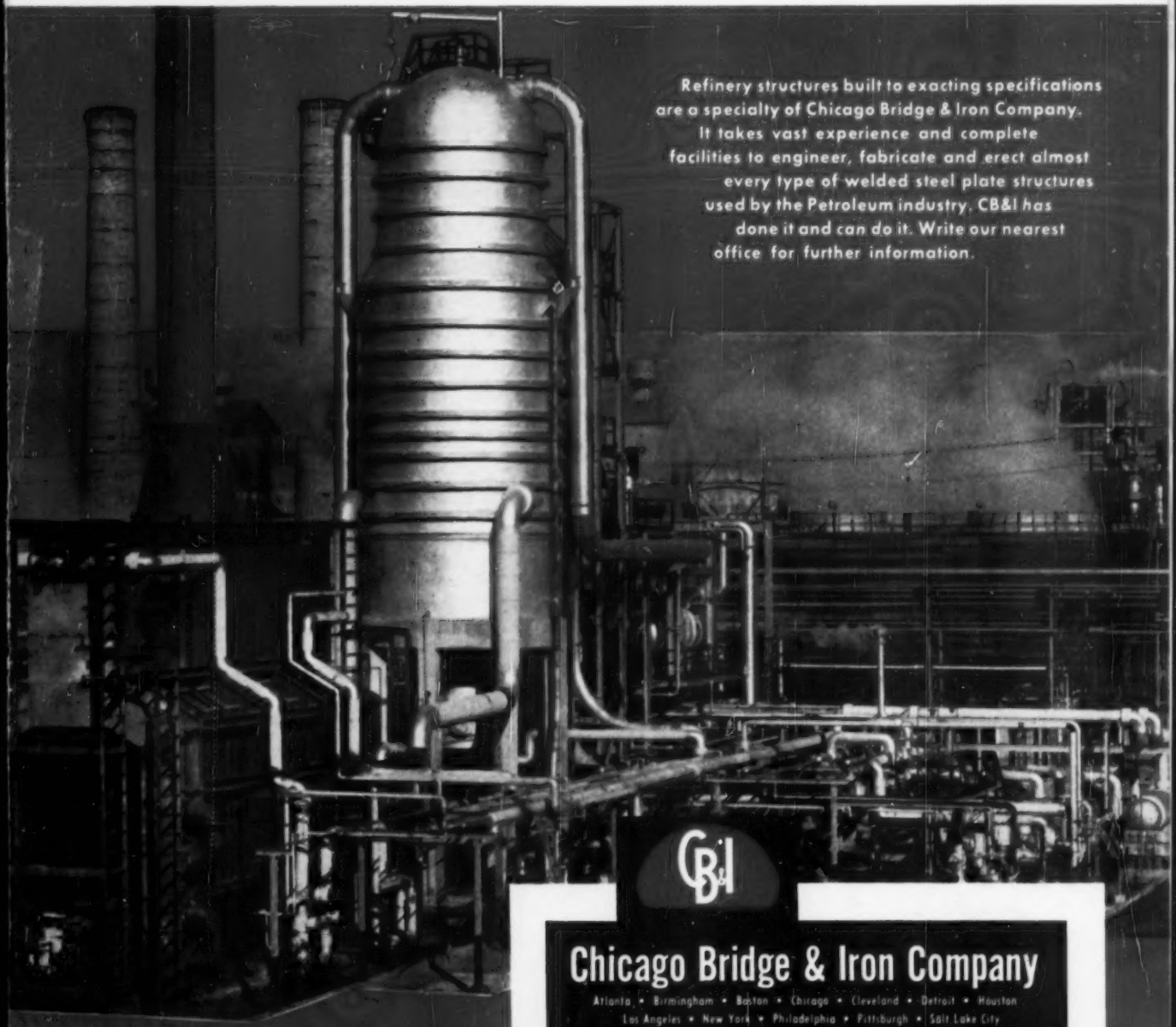
PETROLEUM REFINER

REFINING | PETROCHEMICALS | NATURAL GASOLINE

Gulf Publishing Co.

- **Useful distillation pointers,** Page 104
- **New views on polyforming and HF alkylation,** Pages 161-165
- **New refinery begins with coker,** Page 149

Refinery structures built to exacting specifications are a specialty of Chicago Bridge & Iron Company. It takes vast experience and complete facilities to engineer, fabricate and erect almost every type of welded steel plate structures used by the Petroleum industry. CB&I *has* done it and *can* do it. Write our nearest office for further information.



20-ft. diam. by 64½-ft. vacuum tower built for Esso Standard Oil Company refinery near Baton Rouge, Louisiana.

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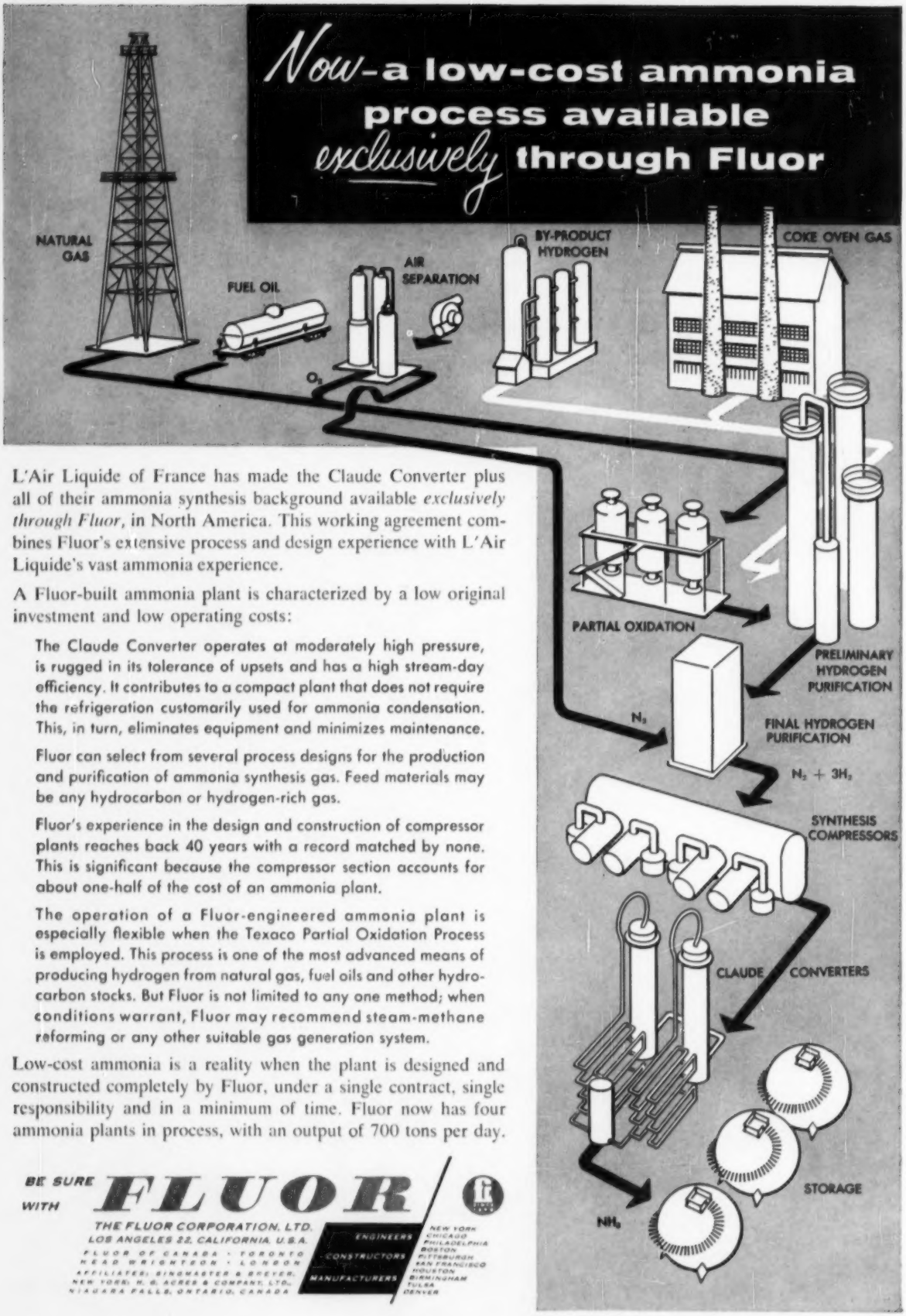

L'Air Liquide of France has made the Claude Converter plus all of their ammonia synthesis background available *exclusively through Fluor*, in North America. This working agreement combines Fluor's extensive process and design experience with L'Air Liquide's vast ammonia experience.

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Volume 34, No. 7 July, 1955

PETROLEUM
REFINER
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A Quick Look
at This Issue

These handy digests permit checking ✓ those articles you want to read first.

DISTILLATION POINTERS

☐ **New Approach to Tray Design . . .** The simple charts presented in this article give an excellent picture of the effects of the vapor and liquid flows as well as physical characteristics of trays. Tested in commercial operation, the trays designed by the proposed method operated satisfactorily in every instance and trays modified according to the charts showed marked improvement in operation. **Page 104.**

☐ **Fast Method for Minimum Plates . . .** The new diagram presented in this article will enable you to estimate the minimum number of plates required for the separation of hydrocarbon mixtures at atmospheric pressures. It's also precise and is applicable in Colburn's method. **Page 109.**

☐ **Nomographs for Slot Openings in Bubble Caps . . .** Slot opening is an important dimension for correlating and predicting pressure drop, entrainment, capacity, efficiency and other operating and design information in distillation. Here are nomographic solutions to otherwise complicated equations for slot openings. Look right away at **Page 111.**

☐ **Efficiency and Pressure Drops for Perforated Plates . . .** New experimental data on a small diameter column show the effect of hole diameter, pressure and vapor rate on the efficiency and pressure drop. **Page 114.**

☐ **New Operating Data for Uniflux Trays . . .** If you have considered application of this new tray design into fractionation towers, this information on experience with them in commercial operating units will be of special interest. Towers using these trays which are either in operation or planned total

→ Now Turn the Page →

250. Application has been in a variety of services. **Page 118.**

☐ **Trends in Turbine Development . . .** Here is a quick review of the mechanical drive turbine development picture, with a look into the future. Keep posted on this important field. **See Page 120.**

☐ **New Reformer Features All-Electronic Instrumentation . . .** This unit has been in operation since August, 1954, with electronic instruments and controls used throughout. The entire system is described. If you would like information on actual plant experience with this type instrumentation, turn to **Page 121.**

☐ **You can Prevent Fatigue Failures . . .** But you must be willing to inspect, stress analyze, fillet, avoid corrosion and streamline. The fatigue of metal is **not** due to crystallization. Metals fail because of stress. Here you will learn how fatigue failures occur, what they are, and how they can be prevented. **Page 127.**

☐ **Absorption and Stripping Design . . .** From the files of a process engineer comes this method for engineering accuracy in the process design of absorption and stripping units. Unlike other design methods, it treats the absorption and stripping systems as one unit. Part II of this series gives an example calculation for the absorber system. **Page 129.**

☐ **What a Relief Valve Can Do . . .** The importance of relief valves to the public welfare has grown to such an extent that all cities, counties, states and the federal government has specific relief valve codes that are strenuously enforced and regulated. In many cases plants are forbidden to start up because of not adhering satisfactorily or completely to a relief valve code. Here is a discussion of those services requiring relief valve protection. **Page 137.**

☐ **Designing Relief Lines . . .** This method, applicable for high pressures, does not require the usual ideal gas and isothermal assumptions. An illustrative problem is worked and the answers are compared with those obtained with other methods. This for your permanent notebook. **Page 141.**

☐ **Decreasing Cooling Water Corrosion . . .** Pitting and tuberculation attributed to the use of anodic corrosion inhibitors can be controlled by the use of a dianodic method of treating cooling water. Here is a description of the treatment and case histories of its use. **Page 144.**

☐ **New Refinery Begins with Coker . . .** Union's newest refinery at Santa Maria, Calif., has only one major process unit—a pair of delayed cokers. Handling heavy, high-sulfur crude, the refinery produces only two finished products—coke and sulfur. A special data reduction system is another unique feature. **Page 149.**

☐ **Operations at the Stanlow Refinery . . .** Here is a review of the various facilities at this large British refinery and petrochemical plant. The new hydrosulfurization unit, scheduled for completion early this year, is described along with the new isopentane unit. **Page 151.**

☐ **Is Carbonyl Sulfide in LPG Corrosive? . . .** Apparently the corrosive effects of carbonyl sulfide in LPG are very minor. Here are the results of an investigation along this line. The equipment used in the study is also described. **Page 155.**

☐ **Determine Vessel Weights Graphically . . .** Weights of vessels, heads, skirts, tray supports and downflow plates, insulation rings, manholes and nozzles can be determined quickly and easily by the use of the charts presented here. These charts also provide a simple means for determining the effect on weight of changes in diameter and length. **Page 157.**

☐ **Still Polyforming in Your Plant? . . .** These economic studies show the effect of butane price and butane/naphtha ratio in the feed stock on profits. Data is based on the operation of a unit in a Conoco refinery and includes a comparison with catalytic reforming. **Page 161.**

☐ **How Cosden's Alkylation Plant Differs . . .** The Cosden HF Alkylation plant differs radically from most of the earlier war-time plants. This new plant uses mixed olefin feed, horizontal contactors, and product defluorination. Operating data from first year's operation show how the plant exceeded design capacity. **Page 165.**

☐ **Industrial Hygiene—Newest Health Tool . . .** Alert management is recognizing the value of this new science dedicated to stressing prevention over cure. Here is how the industrial hygienist fits into the industry, and why he is becoming increasingly important to management in safeguarding employes' health. **Page 102.**

☐ **What's Ahead in Industrial Relations? . . .** In a relatively short time there has been a major transition in employe-employer relations. The worker is now catered to by management, union and the government. He is better housed, better fed, better informed, has more job security than ever before. What more does he want? What will be the trends in future employe-employer relations? For a look into management problems of the future, turn to **Page 222.**

☐ **How Du Pont Combats Alcoholism . . .** The first step toward solving this problem should be management's recognition of its seriousness. With that accomplished, a sound program for rehabilitating these sick employes should be adopted. Here is one that has been 65 percent effective. **Page 232.**

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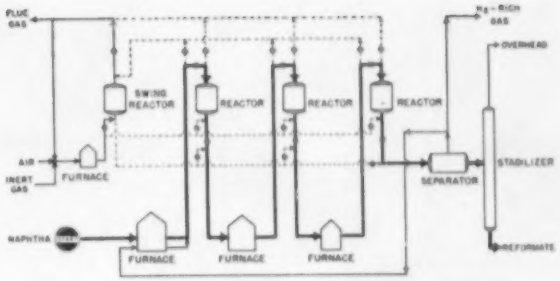

Which Process Is This?

A FLOW diagram can tell a lot about a process but there are many more differences in present catalytic reformers than meets the eye here. In the upcoming September Process Issue you'll find an exhaustive review of all catalytic reforming processes and the economics of getting those top octanes. In this issue, there will also be feature articles giving details on operating data and start-up procedures for processes just appearing with their first commercial installations. Of course, there will also be announcements of new processes, never published before.

The process reflected in the flow diagram is the Ultraforming process. It will be one of those undergoing discussion in this annual special issue on new process developments. September is the month to bring yourself up-to-date on these developments.

Cost Studies—
Our Superior Performance

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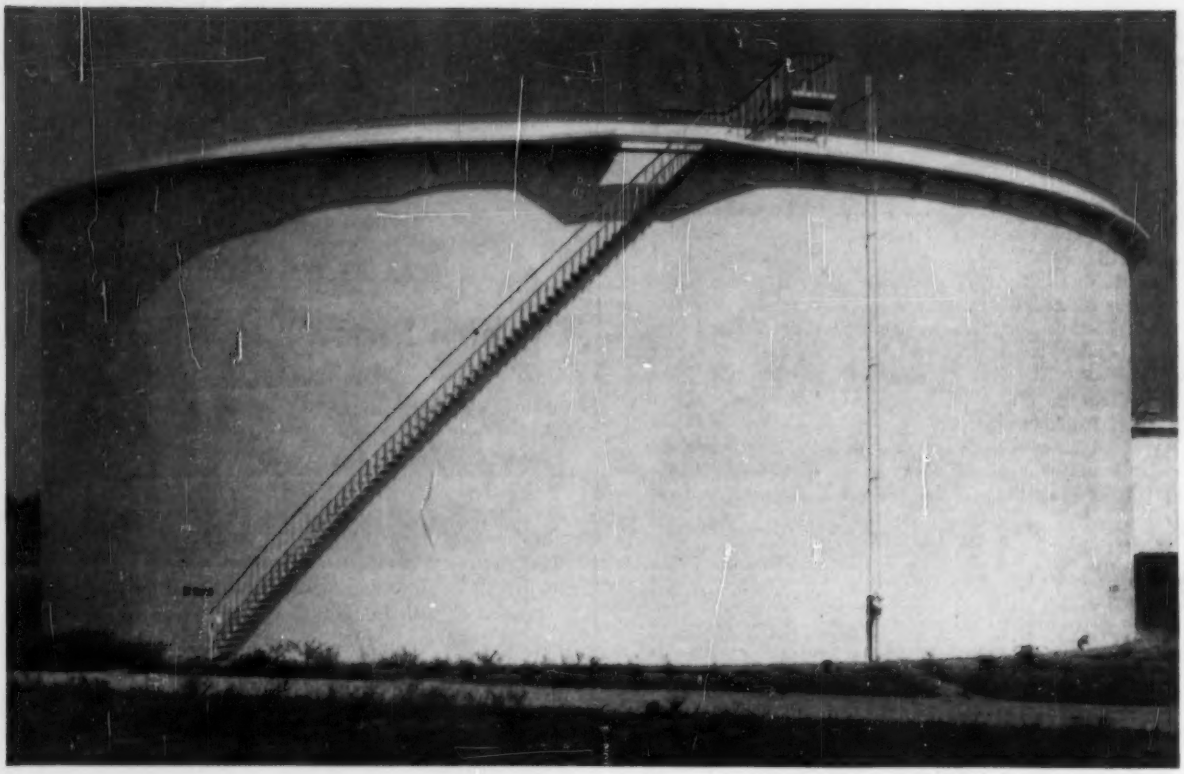
All of which leads us into a brief statistic:

In a recent bibliograph relating to COST STUDIES, compiled by James B. Weaver, Atlas Powder Company and published in June issue of *Chemical Engineering*, PETROLEUM REFINER was so far ahead in the number of authoritative, non-staff, citations for 1954 that it wasn't even a race. Here are the figures:

PETROLEUM REFINER	26
Oil and Gas Journal	17
Petroleum Engineer	11
Petroleum Processing	9

Cost studies being so important in these days when economics is the BIG factor in manufacturing, we're right proud of our performance and pledge that there'll be no letdown in the future.

And here's another interesting cost figure: PETROLEUM REFINER will be sent to your address for $2 per year!



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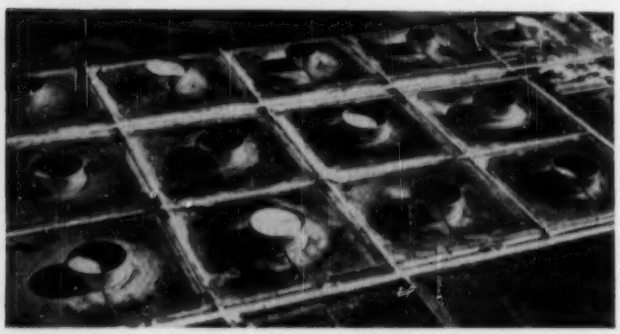

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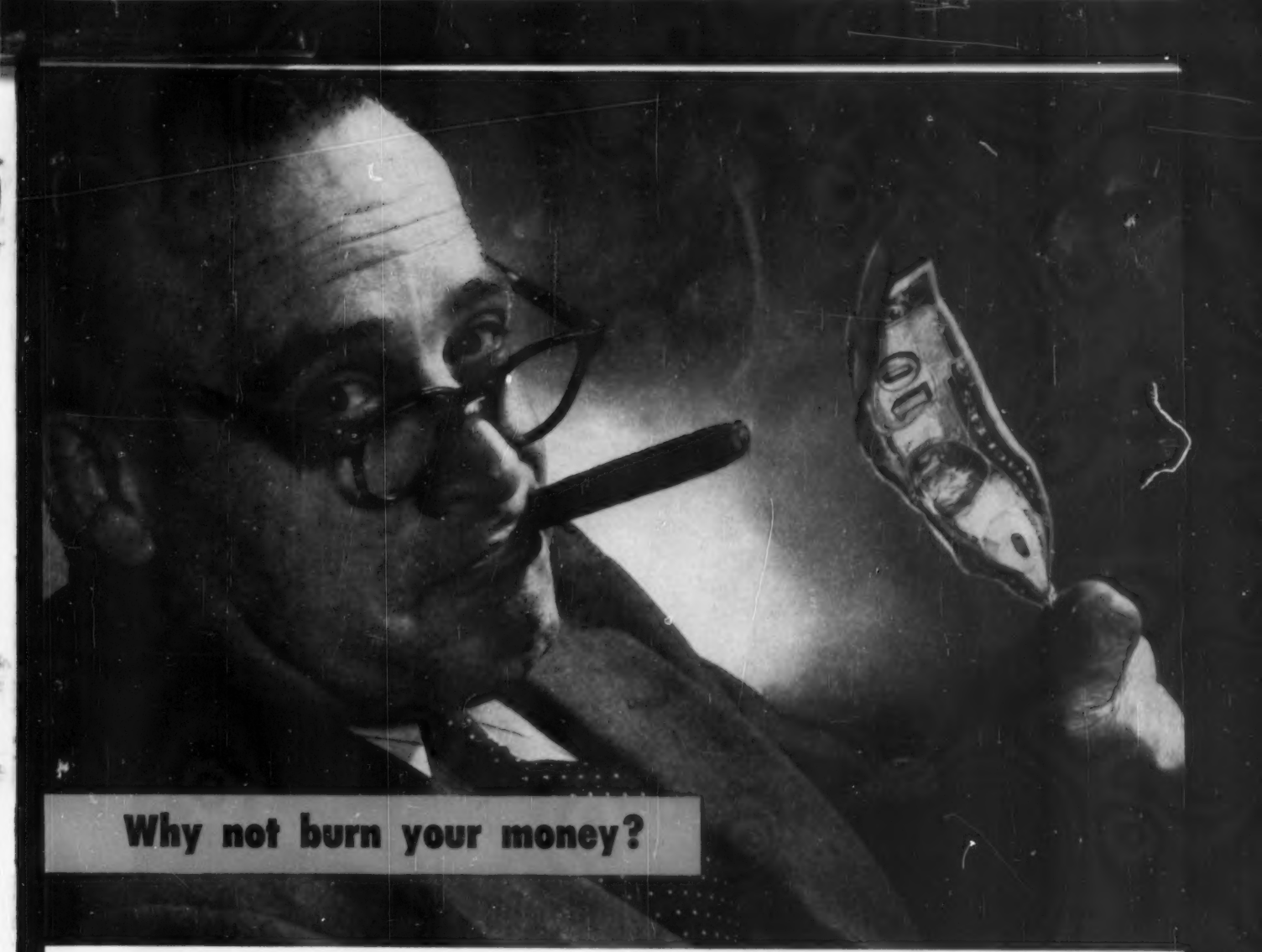

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INSIDE STORY
on cooling tower pH

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For it's here, *inside the tower*, that vital pH control can be most effective for slime control, scale prevention, wood protection, and conservation of make-up water.

We'll be glad to send you details on the "inside story" of tower pH. Write Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Pa., for Process Data Sheet 700(1).

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POWELL LUBRICATED PLUG VALVES

FIG. 3059G—300-Pound Steel Flanged End Valve. Sizes 6" to 12".

FIG. 1559—150-Pound Steel Flanged End Valve. Sizes 1" to 4".

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POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES

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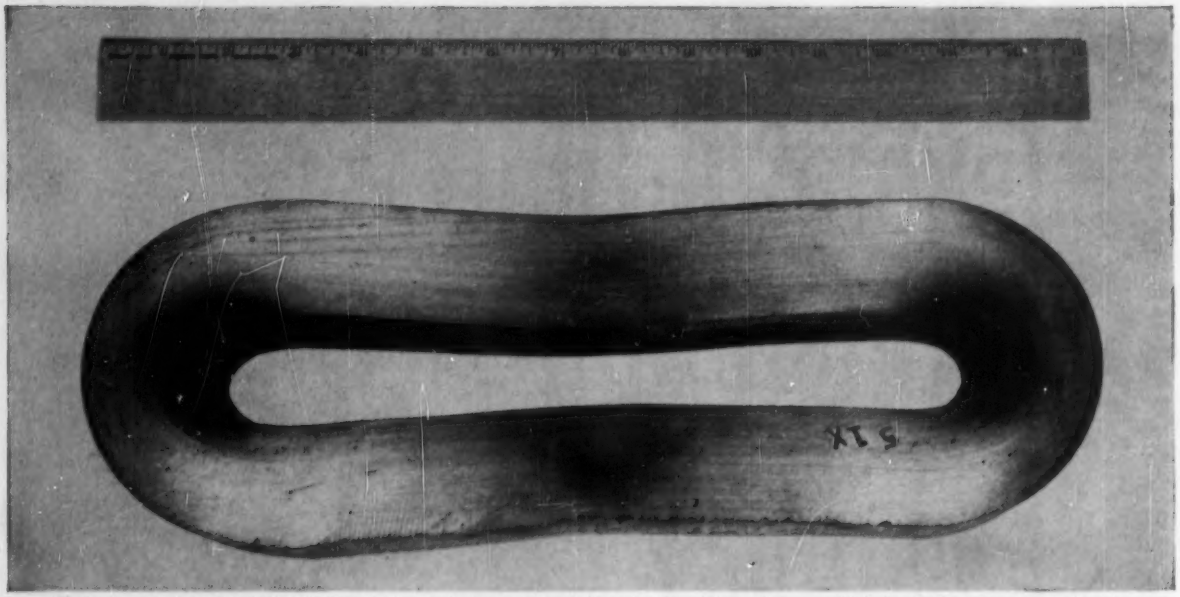

Flattening test of 10⅛" O.D. by 1.580" wall of 18-8 Cb showing the excellent ductility of large, heavy-wall Timken high temperature steel tubing.

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DM-2	2½% Cr.-1% Mo.	Sicromo 7	25-20*
Silmo	Sicromo 3	Sicromo 9M	25-12*
DM	4-6% Cr.-Mo.	18-8 Stainless	35-15**
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	16-25-6**

** Available as seamless tubing on an experimental basis only.*
***Not available as seamless tubing.*

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YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

HOW TO INCREASE ABSORBABLE COMPONENT RECOVERED WITHOUT INCREASING HEIGHT OF PACKED COLUMN

We alternately packed a pilot plant tower first with 10′ of Raschig Rings and then with 10′ of Intalox Saddles. Using identical gas and liquid rates and the same gas composition, absorption data for the two packings were obtained. One swallow, of course, doesn't make a summer, so we repeated the test again and again to be sure our original conclusions were justified.

If you're facing the problem of recovering a higher percentage of absorbable component from your present absorption towers, *it appears obvious* that you can increase the absorption level as much as 30% or more by replacing Raschig rings with Intalox Saddles. And without changing either liquid or gas rates!

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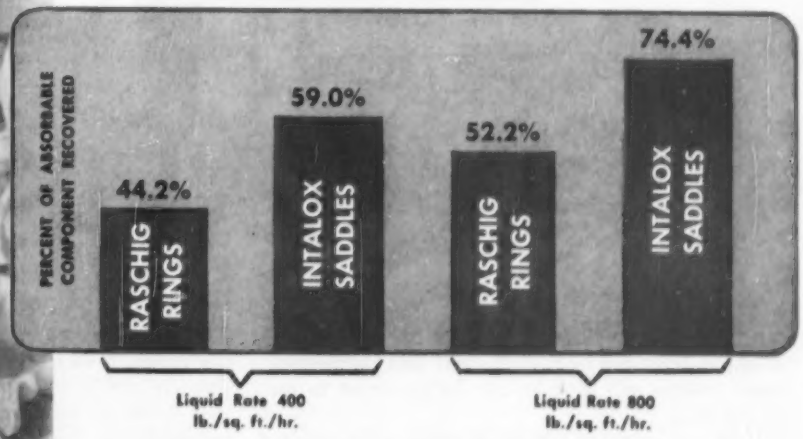

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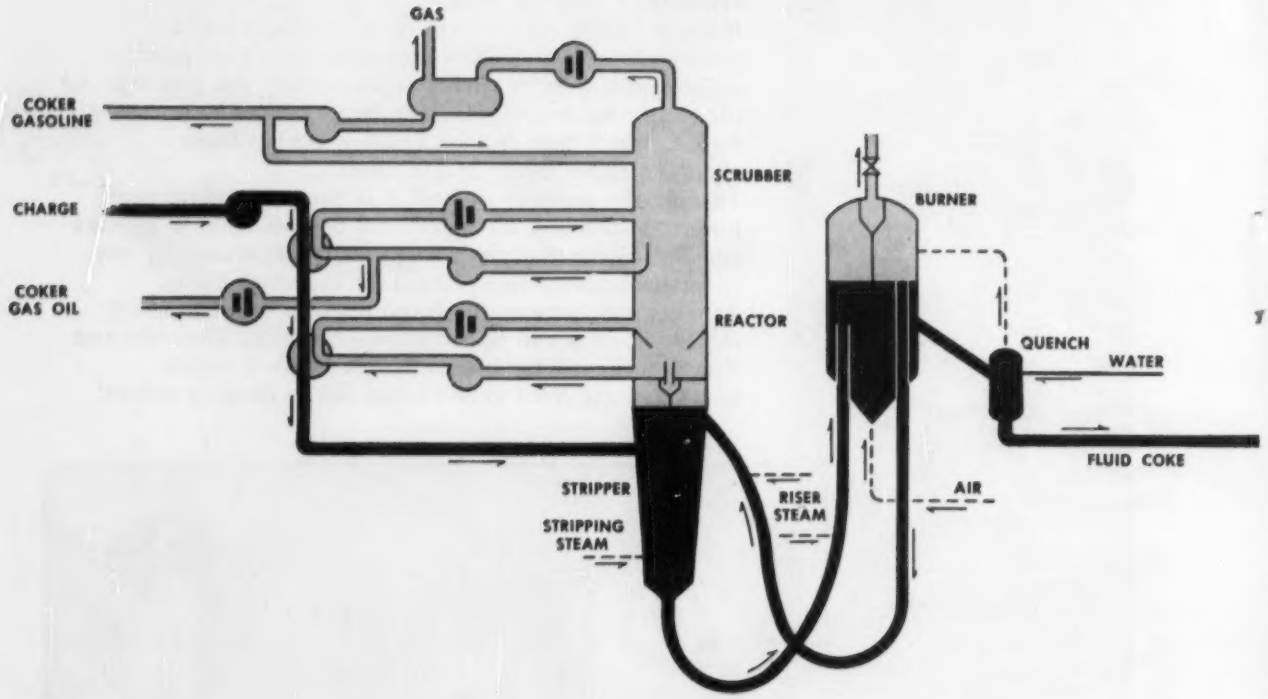


IN THIS latest application of the fluidized-solids technique, developed by Esso Research and Engineering, heavy residua and asphalts can be converted to gas, oil and coke.

As shown in the flow diagram above, finely divided coke particles flow between two vessels—a burner and a reactor. In the burner, part of the coke stream is burned to supply the heats for vaporization, cracking and losses. When this hot coke meets the feed in the reactor, coking results and the liquid products are flashed off.

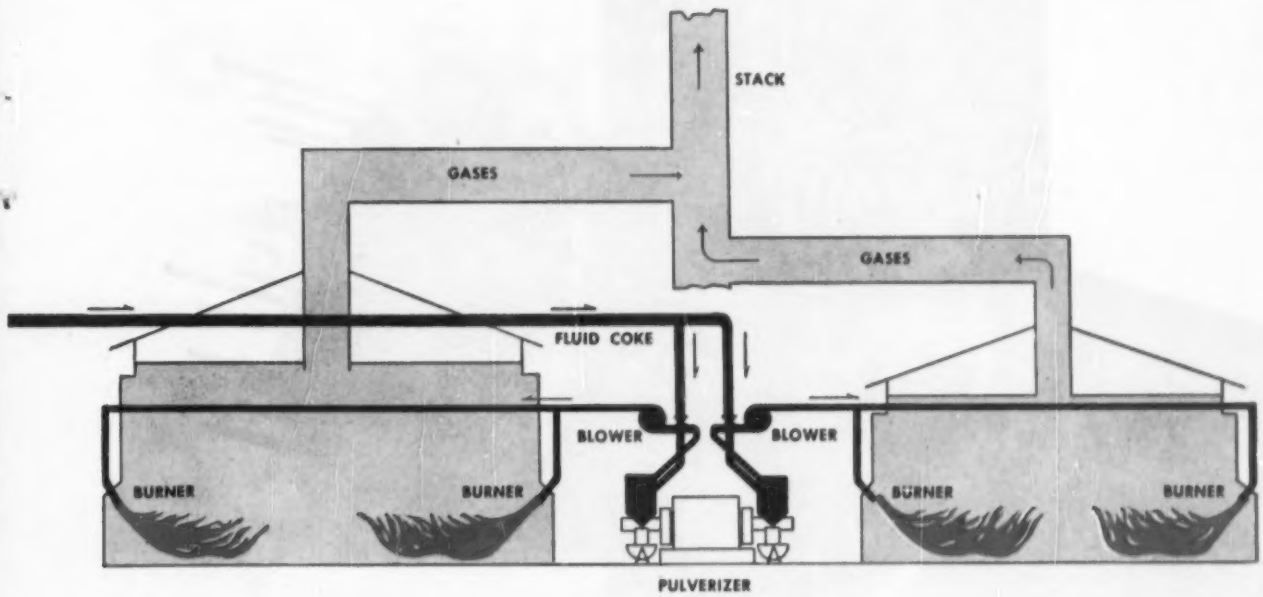
Coke particle size ranges between 75 and 150 microns and the coke itself is a clean, dustless solid. The feed is preheated through two fractionator (scrubber) pump-around systems. In the reactor it contacts the hot coke flowing from the burner. Coke is formed as the fluidized bed moves down into the stripper section where steam removes any remaining volatiles. The stripped coke then flows into the burner where, in contact with air, approximately 5 per cent by weight of the charge is burned. The coke inventory in the unit is fixed and the excess is removed as product coke which is cooled by water spray before flowing to storage.

The vapors from the reactor pass into the scrubber-fractionator section where they are separated into gas, gasoline and gas oil.

FOSTER

coke

...and utilization



THE USE of fluid coke as a fuel is illustrated in the above simplified diagram of two heaters designed by Foster Wheeler for a large oil company. They will supply the heat requirements for the atmospheric and vacuum sections of the highest capacity crude distillation unit in the world, having a combined heat absorption capacity of 336,400,000 btu per hour.

The pulverizers which reduce the particle size of the fluid coke before it is burned in the furnaces, as well as the pulverized coke burners, are also of Foster Wheeler design.

Designs are also available for the burning of fluid coke in steam generators.

Foster Wheeler's experience in the design of equipment for both the *production* and *utilization* of fluid coke will be of value to any process plant interested in converting heavy residua into cracking stock and making effective use of the resulting solid fuel. For further details on this process, or for proposals to meet your specific requirements, write to *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FW WHEELER

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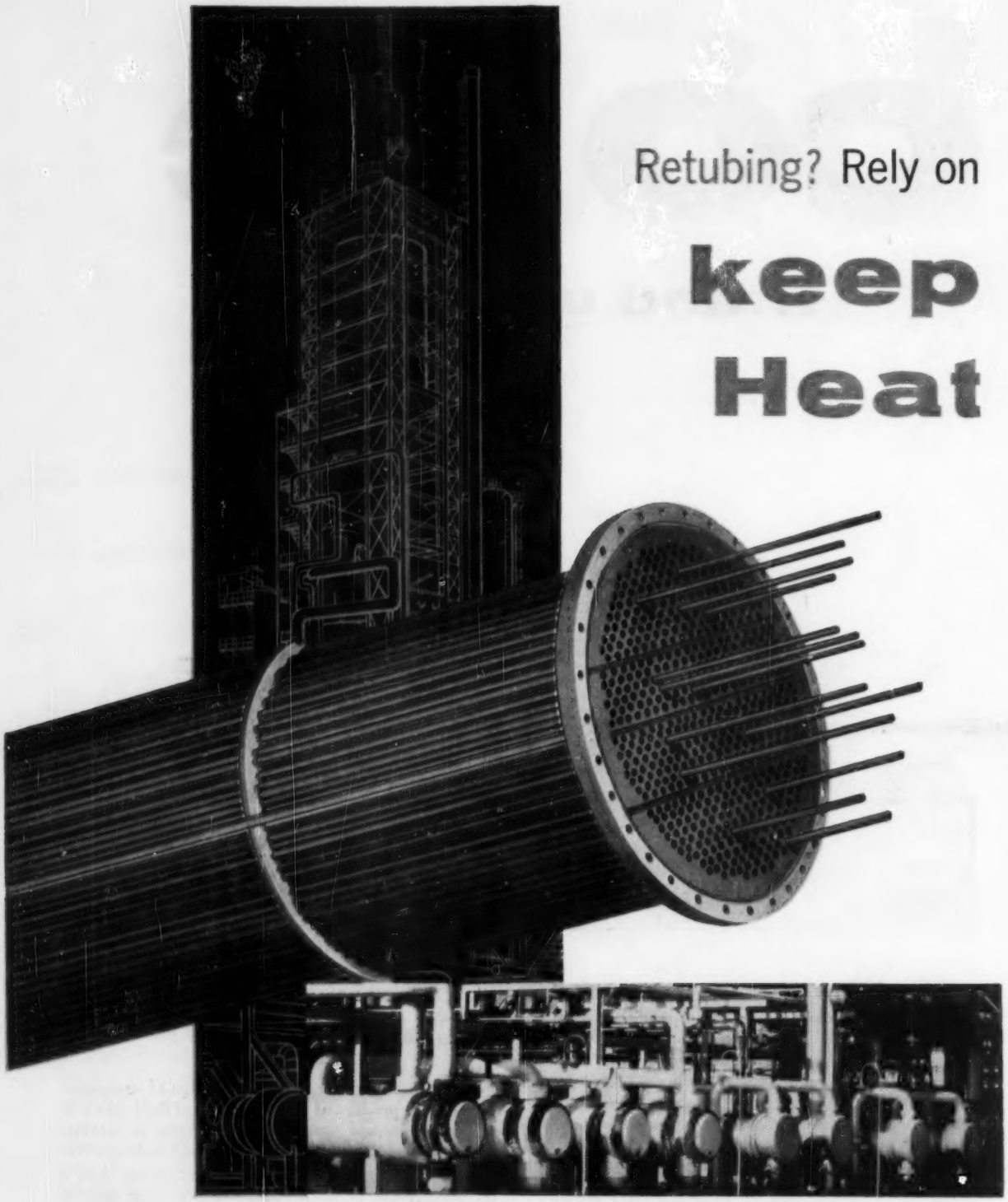
Retubing? Rely on

keep Heat



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Phelps Dodge COPPER-BASE ALLOY Tubes to

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- ✓ **Complete line of copper-base alloys** including Bi-Metal combinations to meet special corrosive conditions.
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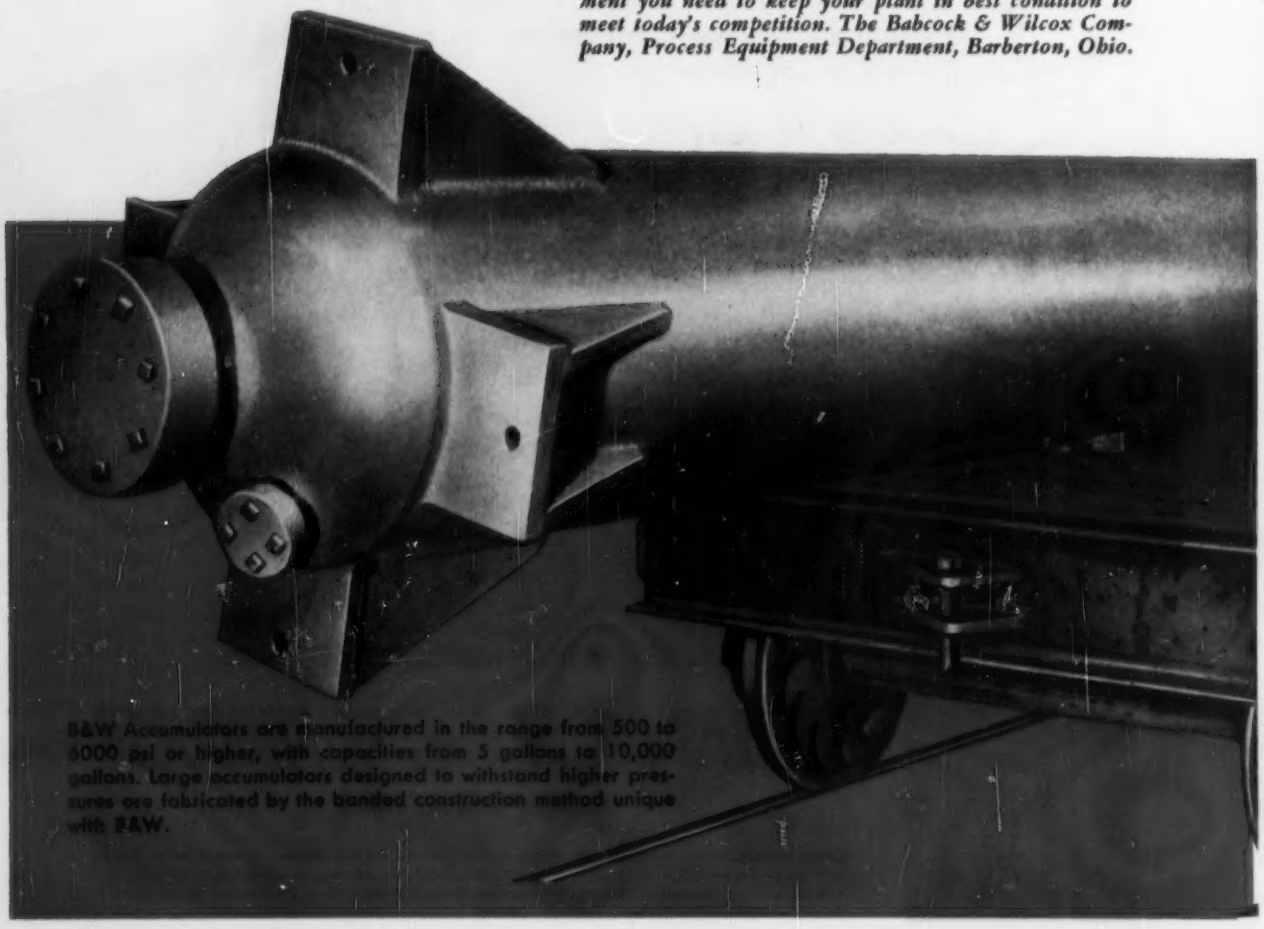
B&W Accumulators and other Pressure Vessels
• Alloy Castings • Hollow Forgings

The constant progress being made within the process industries demands the utmost of the engineers responsible for the dependability, efficiency and economy of the equipment that serves today's process industries' requirements.

At B&W, forming, machining, welding, X-raying and stress relieving are all performed on equipment specially designed for the job, much of it developed by B&W. And for temperature and pressure problems that arise, new and practical solutions are continually being developed through designing skill based on long experience.

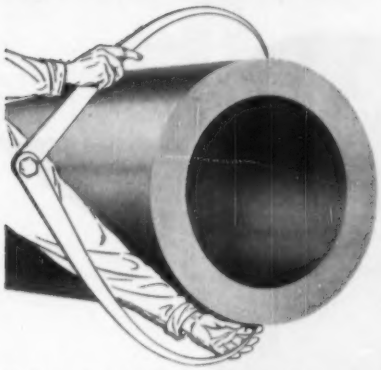
Write for detailed information about the B&W equipment you need to keep your plant in best condition to meet today's competition. The Babcock & Wilcox Company, Process Equipment Department, Barberton, Ohio.



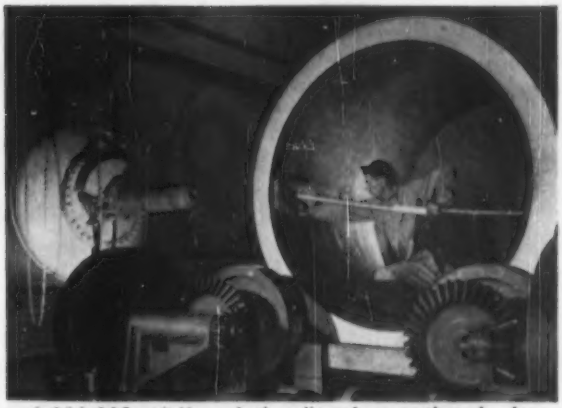
B&W Accumulators are manufactured in the range from 500 to 6000 psi or higher, with capacities from 5 gallons to 10,000 gallons. Large accumulators designed to withstand higher pressures are fabricated by the banded construction method unique with B&W.

ment

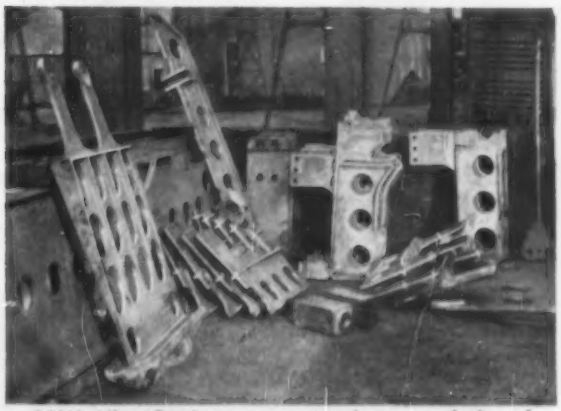
requirements



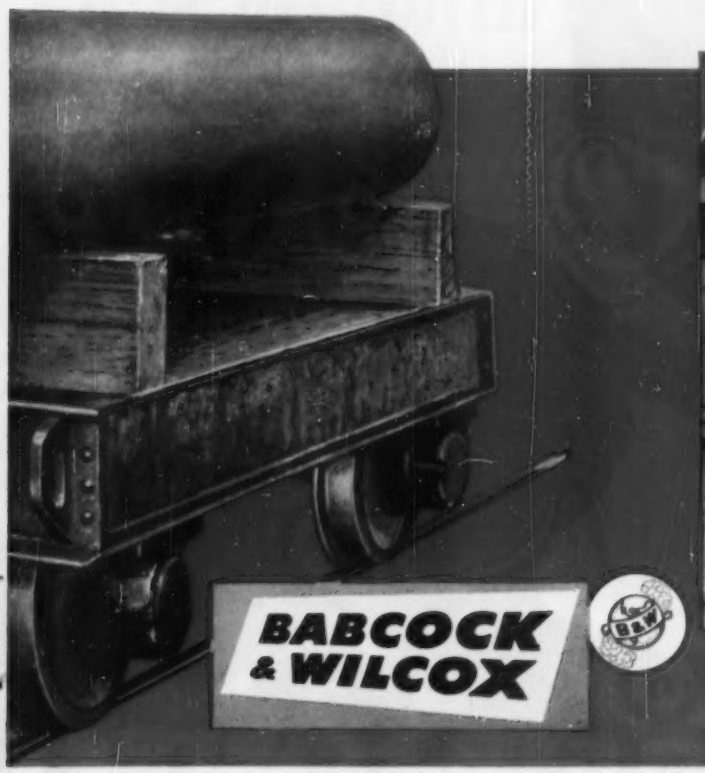
B&W Hollow Forgings are large-diameter, heavy-wall pipes or tubes that offer the designer the advantages of single lengths or many lengths, "tailor-made" to his requirements . . . prompt delivery even on small orders . . . full forging properties resulting from thorough working of the metal . . . excellent concentricity . . . a wide size range. They are supplied in a wide range of carbon and alloy steels, produced in accordance with ASTM Specifications A106, A266, and A335.

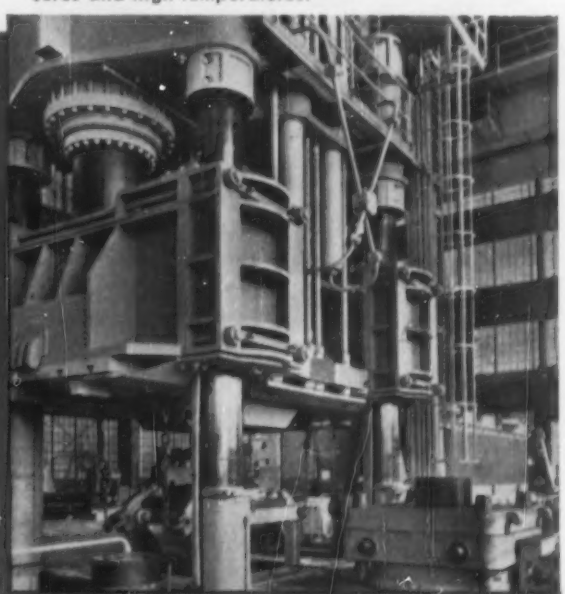


2,000,000-volt X-ray is the all-seeing eye that checks the soundness of welds.



B&W Alloy Castings are cast-to-last . . . designed for long life under the most rigid service conditions requiring superior resistance to abrasion, high pressures and high temperatures.





B&W's giant new press, used in making Hollow Forgings and other products needed to meet industry's growing demands.

S-434

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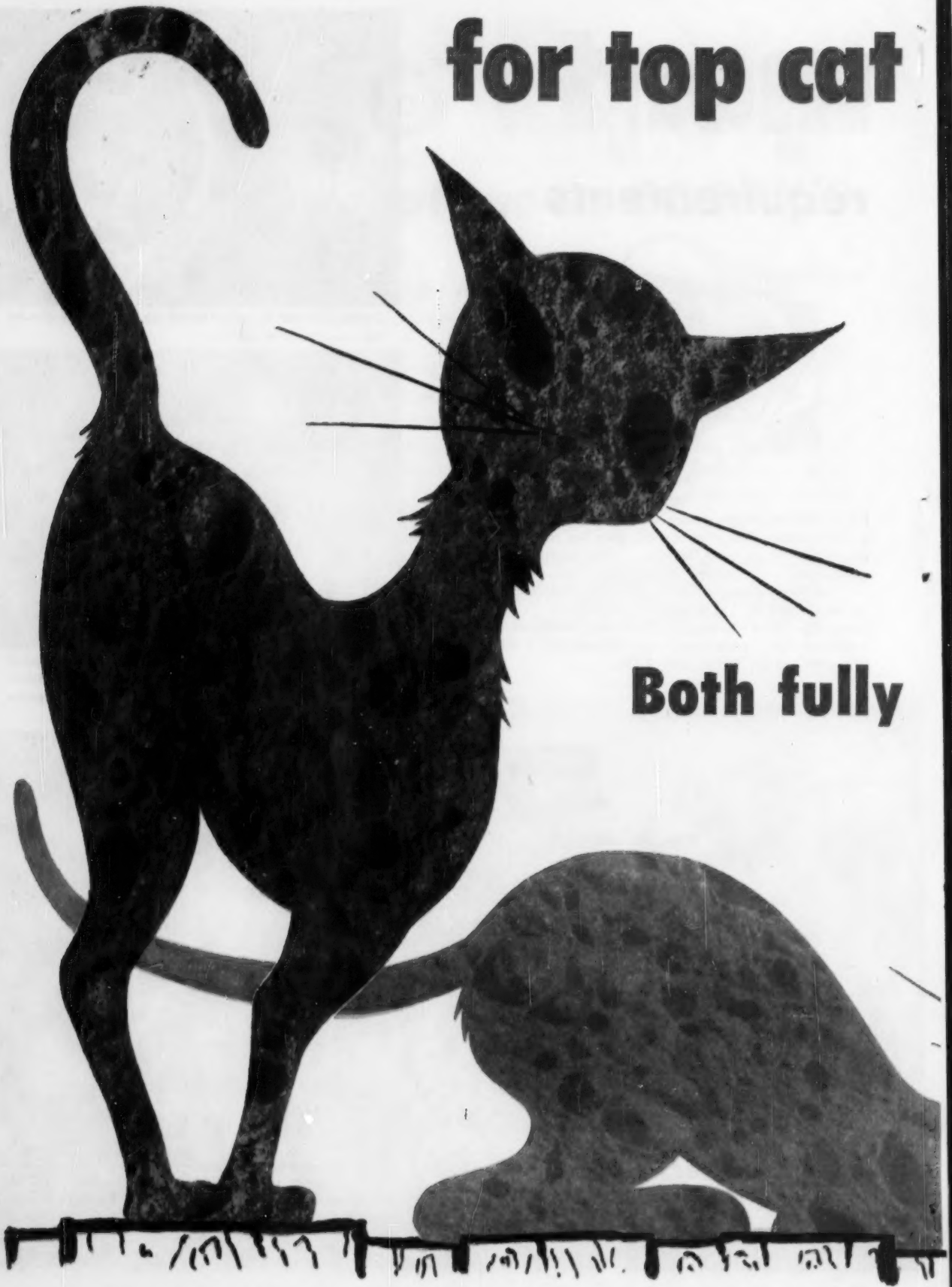
for top cat
Both fully

cracking efficiency...

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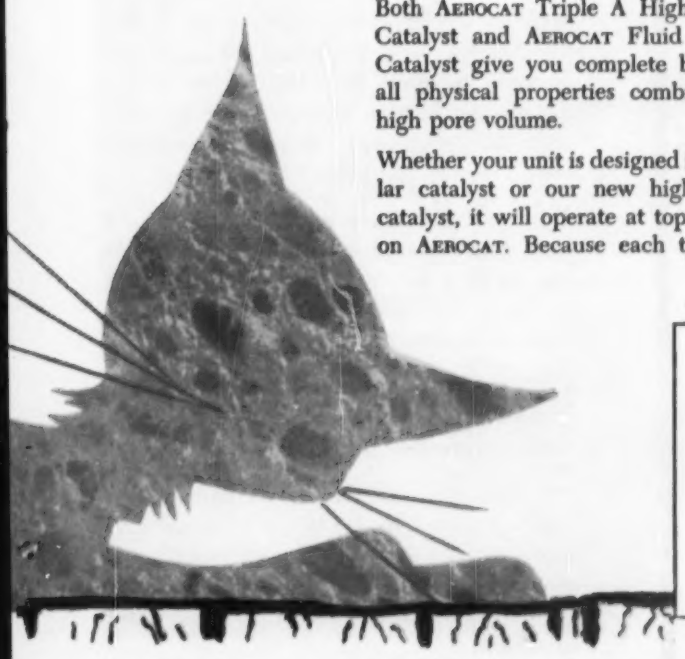
Aerocat Triple A*

High Alumina Catalyst

Aerocat®

Fluid Cracking Catalyst

balanced with High Pore Volume



Both AEROCAT Triple A High Alumina Catalyst and AEROCAT Fluid Cracking Catalyst give you complete balance of all physical properties combined with high pore volume.

Whether your unit is designed for a regular catalyst or our new high alumina catalyst, it will operate at top efficiency on AEROCAT. Because each type offers optimum balance of pore volume with pore diameter, particle shape, particle size distribution and hardness.

Remember Cyanamid was first to deliver a commercially successful high alumina catalyst, first to deliver high pore volume in balance with other catalyst properties. Ask your Cyanamid Representative about AEROCAT Catalyst with high **PV.**

*Trade-mark

AMERICAN Cyanamid COMPANY
REFINERY CHEMICALS DEPARTMENT
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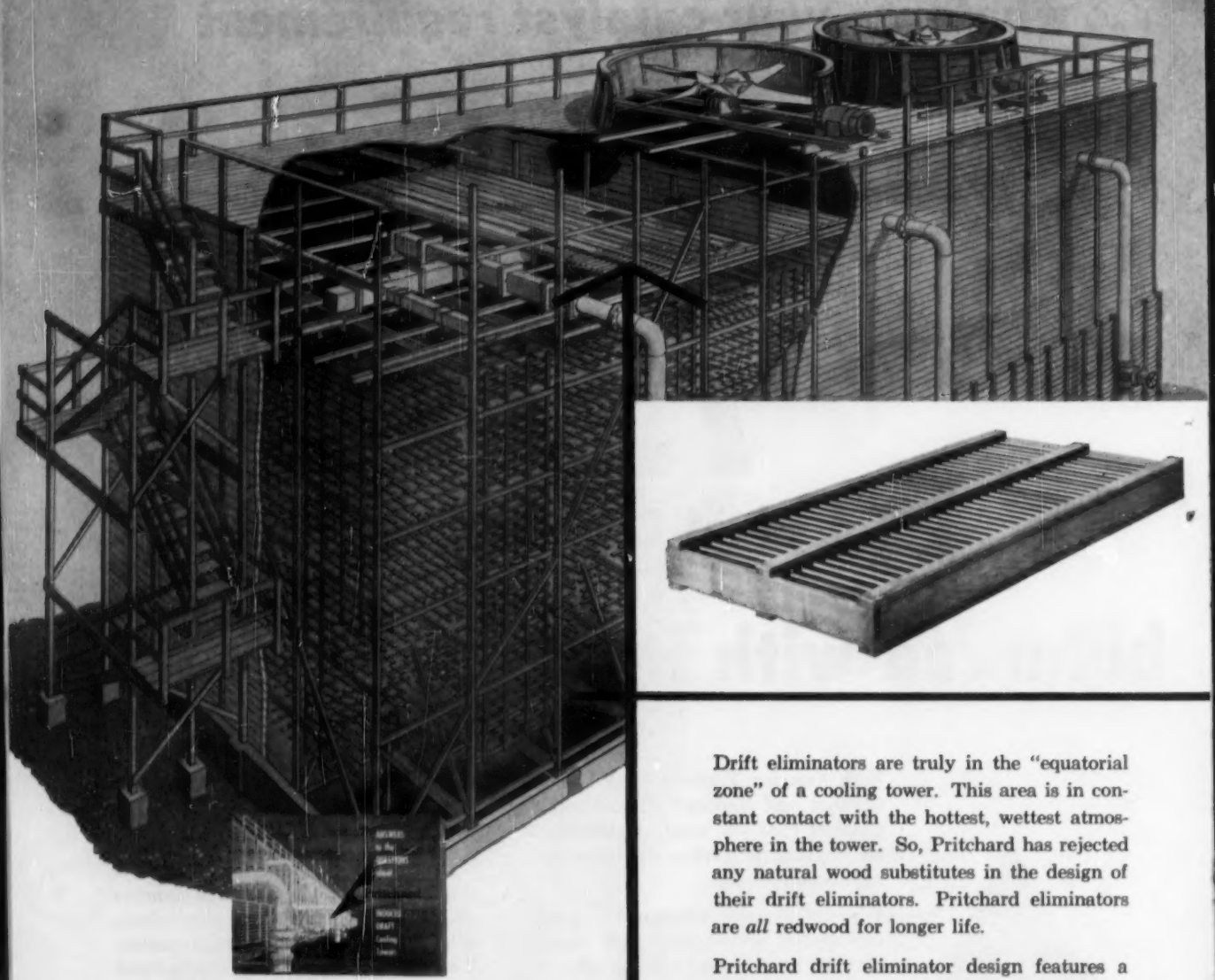
ONE MORE REASON TO CHOOSE PRITCHARD COOLING TOWERS:

GREATER STRENGTH AND RIGIDITY FOR THE "EQUATORIAL ZONE"!



Drift eliminators are truly in the "equatorial zone" of a cooling tower. This area is in constant contact with the hottest, wettest atmosphere in the tower. So, Pritchard has rejected any natural wood substitutes in the design of their drift eliminators. Pritchard eliminators are *all* redwood for longer life.

Pritchard drift eliminator design features a rigid framework. Surfaces that reduce drift loss are in a constant position for high drift recovery. Yet, blades, carried in slots, can expand and contract freely.

Pritchard ships the 3′ x 6′ drift eliminator sections completely assembled even when the customer provides field labor.

And Pritchard drift eliminators cover the entire plan area of the tower *above* the distribution system resulting in better air flow pattern and superior performance. How superior? A guaranteed drift loss of less than 0.2% of water circulated!

GET ALL THE FACTS! Get your complimentary copy of the new Pritchard brochure "Answers to the 15 Questions about Pritchard Induced Draft Cooling Towers." Fascinating reading to anyone interested in cooling towers. Completely illustrated. Full of tips on evaluating cooling tower bids, factors in choosing towers. Your complimentary copy awaits—write for it today on your company letterhead!

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GAS & AIR TREATING EQUIPMENT

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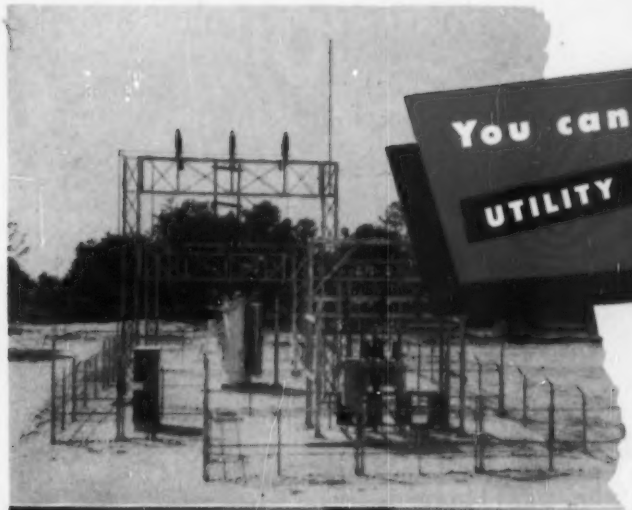

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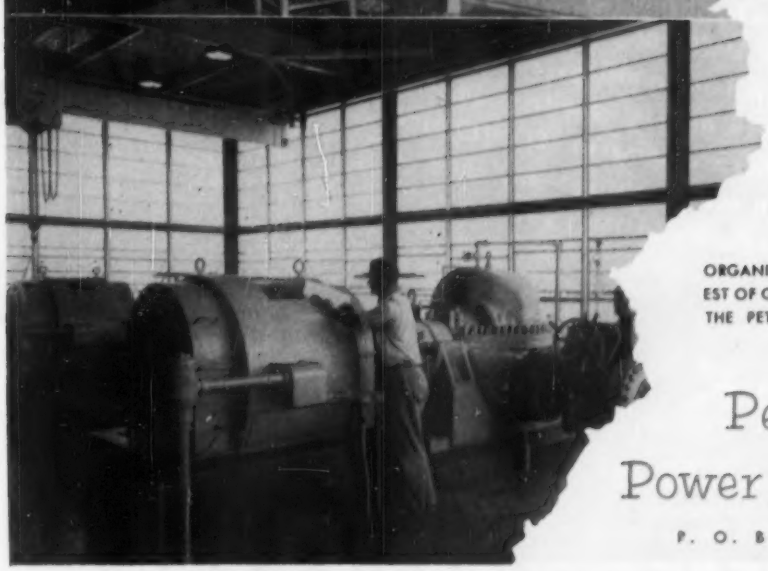
Modern. Low-Cost. Automatic. Labor Saving. Pushbutton Control ... That's what this pipeline service company gets from Utility Electric Power. The rock bottom economy of using Utility Electric Power ... plus the advantages of clean, dependable, and trouble-free efficiency ... makes Utility Electric Power your BEST BUY for meeting any power requirement.

CALL YOUR LOCAL ELECTRIC UTILITY COMPANY FOR POWER FACTS



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Petroleum Electric Power Association

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Confidence cannot be bought over the counter. It must be earned through years of satisfactory experience. Confidence dearly. earned is a manufacturer's most valuable asset. Confidence is the basis upon which the major oil producers buy equipment to ship to far away places. Throughout the world, where oil is produced, refined, stored or transported—there you will find S&J vapor conservation, tank safety, and automatic gaging equipment.

The equipment for use in the Sterling Areas is made in England by Whessoe, Ltd. That for use in the Dollar Areas is made in the United States by Shand & Jurs Co. Whether you BUY BRITISH or BUY AMERICAN, you get identical equipment, made from the same drawings—to the same specifications. Whether you deal in Pounds or Dollars, whether you figure in inches or centimeters—CONFIDENCE means the same thing in every language—any place on earth. That's why, where there's oil, there's S&J.

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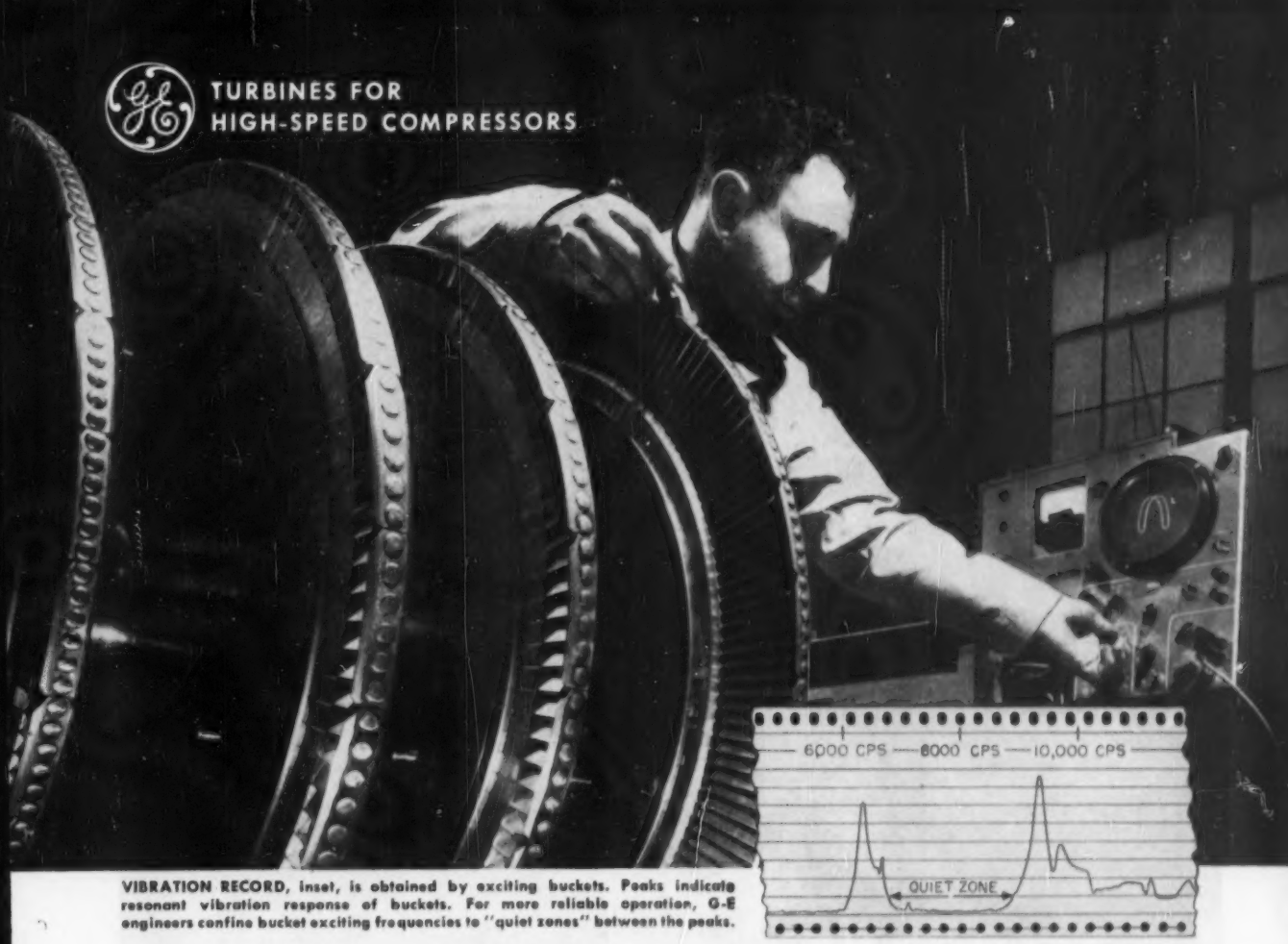
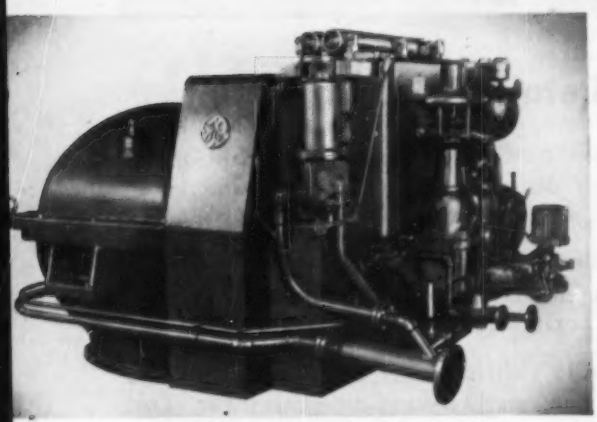
TURBINES FOR
HIGH-SPEED COMPRESSORS



VIBRATION RECORD, inset, is obtained by exciting buckets. Peaks indicate resonant vibration response of buckets. For more reliable operation, G-E engineers confine bucket exciting frequencies to "quiet zones" between the peaks.

How G-E Engineers Locate "Quiet Zones" for Safer High-speed Turbine Operation



TYPE DRV HIGH-SPEED MECHANICAL-DRIVE TURBINE

When driving modern compressors and blowers, G-E high-speed turbines spin at operating speeds of 7000 rpm and up. At such speeds, if resonant vibration were not controlled carefully, bucket fatigue failure might result.

HERE'S HOW General Electric combats the problem: Natural vibration frequencies of the buckets on each new turbine rotor are determined with the special equipment shown above—an oscillator, crystal pick-up, and high-speed level recorder. "Quiet zones" of minimum normal vibration are clearly revealed.

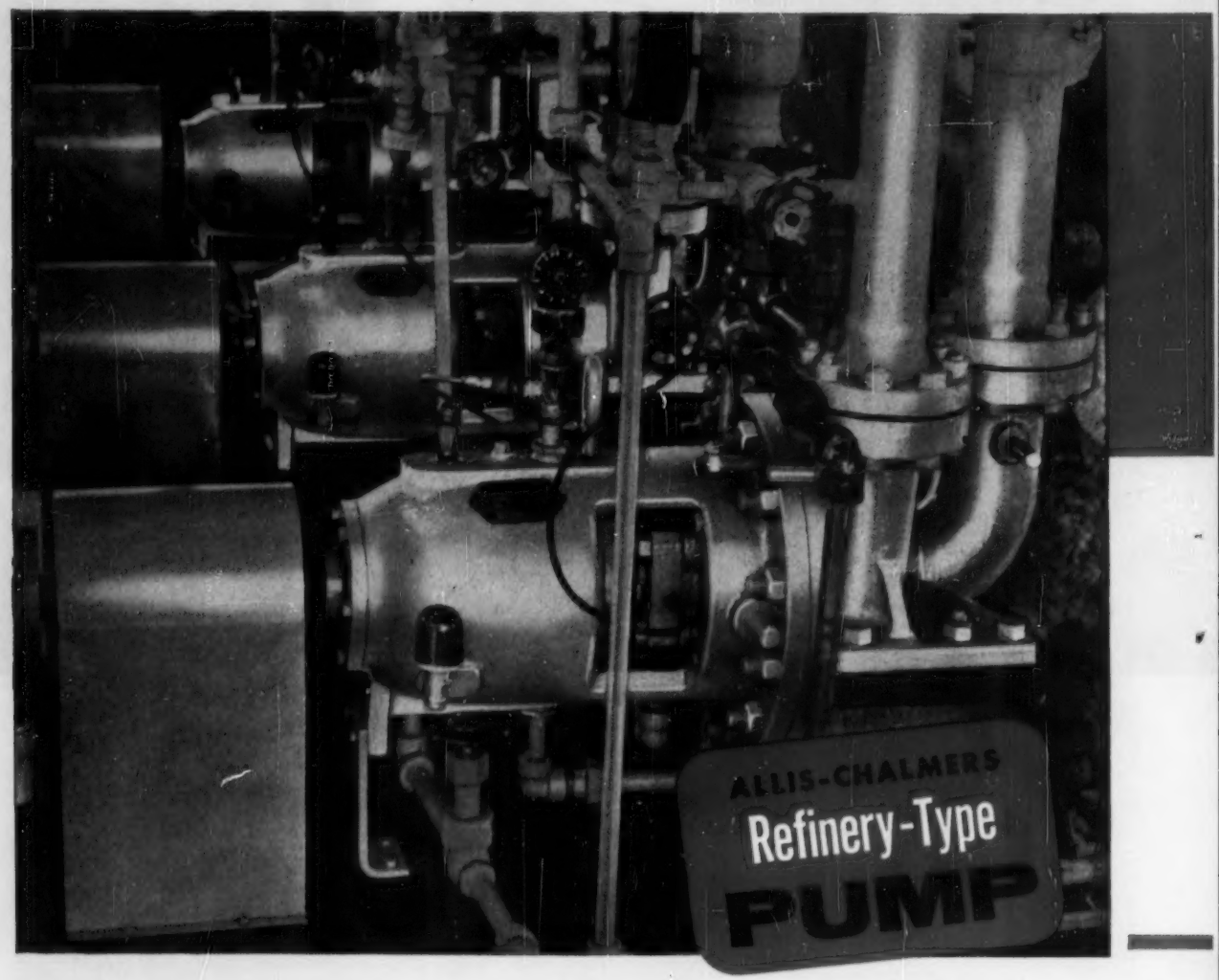
With this information available, the number of nozzles can be varied so that steam striking the buckets will create vibration-exciting frequencies only in these "quiet zones." By thus making sure that steam-impact frequencies don't coincide with critical natural frequencies, the chance of bucket failure is greatly reduced.

VIBRATION TESTING is one of many features that add to the reliability of G-E high-speed turbines. For more information, contact your nearest G-E Apparatus Sales Office or write General Electric Company, Schenectady 5, N. Y. 141-2

Progress Is Our Most Important Product

GENERAL ELECTRIC

Sun Oil uses



Ample Reserve Strength in Every Detail of Construction

Sealing — Various types of packing and mechanical seals or combinations of both can be obtained to suit the application.

Cooling of stuffing box and bearings can be provided by water or oil, in five separate places. Water-cooled pedestal available for extremely high temperature operation.

Wearing rings, front and rear, are provided on both impeller and casing.

Shaft and bearings are of exceptionally heavy design to reduce deflection and vibration, assure long wear, low operating costs.

Throat bushing and base ring are renewable. Close fit on shaft reduces infiltration into stuffing box. Cannot blow in or out.

Double volute casing used on pumps above 400 gpm greatly reduces deflection forces. Low NPSH design successfully handles highly volatile liquids at high temperatures.

ALLIS-

eleven of these pumps

Where Service Continuity Is Essential

ELEVEN of these Allis-Chalmers refinery-type pumps are installed on a variety of continuous duty applications at a refinery of the Sun Oil Company, Limited. They are top suction, water-cooled units with standard high temperature packing. These pumps have the stamina to keep going on the toughest applications for years without down time. Every construction detail has been carefully engineered to provide ample reserves of strength and durability.

wide choice of materials and features

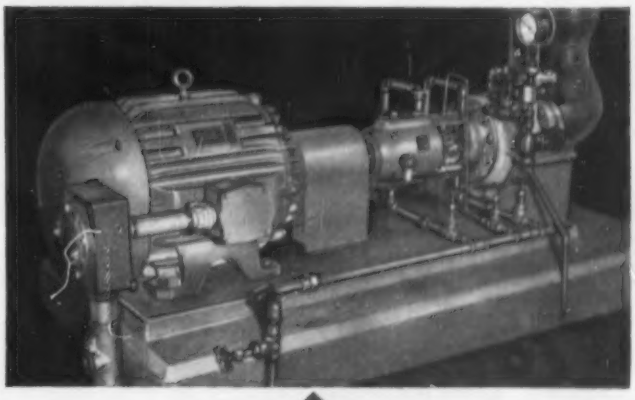
The Allis-Chalmers refinery pump can be fitted to suit your requirements exactly. Practically any material normally used in pumps may be specified. Stuffing box takes packing, mechanical seal or both. Cooling water or oil may be used in five separate places, so you can select exactly the cooling arrangement for your particular needs. Suction may be at top or on end.

get complete information

Your nearby Allis-Chalmers representative will be glad to help you with your refinery pump problems. Or write for Bulletin 52B7775. Allis-Chalmers, Milwaukee 1, Wisconsin. A-4557

get complete unit / pump motor control

Allis-Chalmers will supply a complete pumping unit — pump, motor and control — engineered to work together and with pump and motor mounted on a single base plate ready for installation. You save engineering time because you don't have to match components from different manufacturers. You save purchasing time — only one order. And, most important, you are sure that the components will work together to give you long life at low operating cost. The complete unit is covered by a single guarantee backed by Allis-Chalmers well-known customer satisfaction policy.



CHALMERS

A-C ALLIS-CHALMERS

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The USS Forrestal—

another example of how Walworth helps protect a 200 million dollar investment

Walworth products installed aboard the *USS Forrestal* include gate, globe, and lubricated plug valves and pipe fittings. They are used on high pressure air lines, fire mains, and most of the other piping systems throughout the ship.

Thousands of Walseal® Bronze Valves, Fittings, Flanges, and Unions comprise the major portion of the Walworth installations.

Walseal is a registered trade mark which identifies valves and fittings manufactured by the Walworth Company. Walseal products have *factory-inserted rings* of silver brazing alloy in threadless ports. Walseal joints can be made only with Walseal valves and fittings.

WALWORTH

valves . . . pipe fittings . . . pipe wrenches

60 East 42nd Street, New York 17, N. Y.

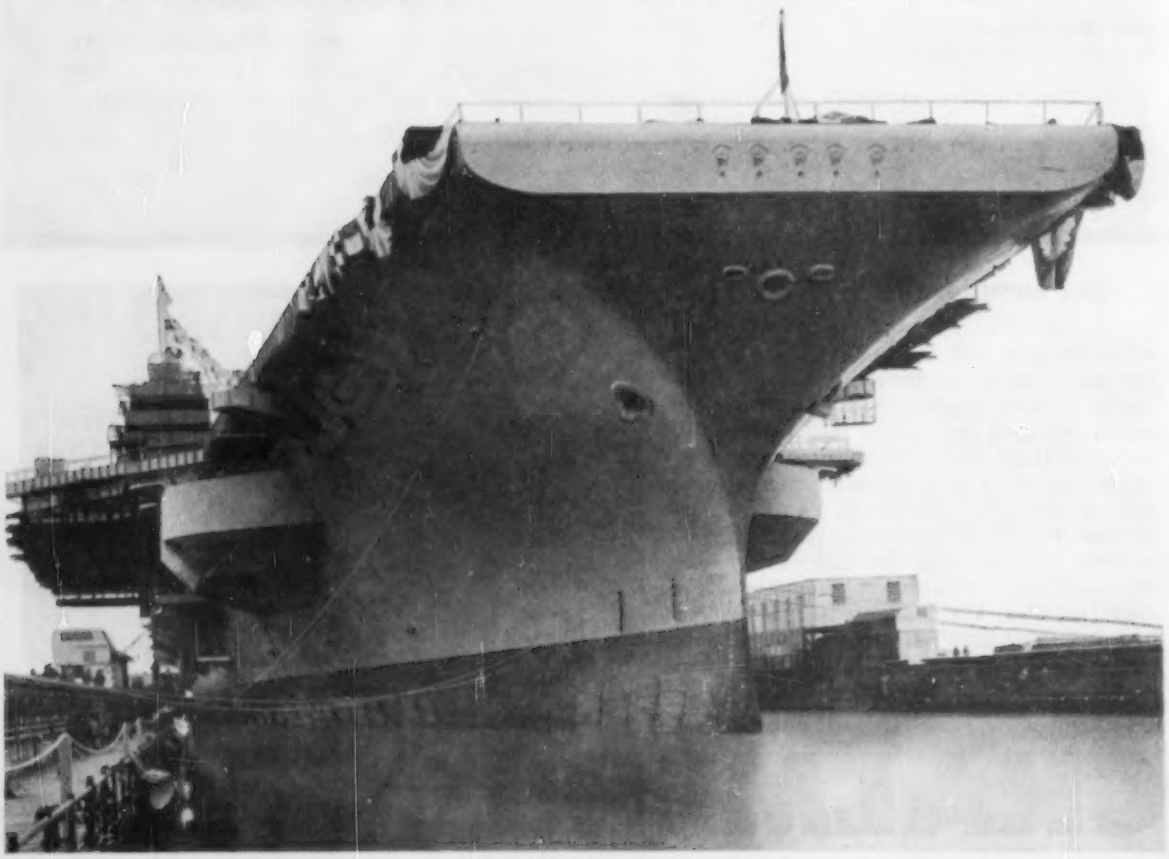
Walworth Company of Canada, Ltd., Toronto

Keel laying to launching—Walworth was there.

Walworth engineers worked with designers, metallurgists and builders of the mighty flat-top right from the blueprint stage. Their efforts assured the builder – Newport News Shipbuilding and Dry Dock Company – that *every* Walworth Valve and Fitting installed would meet *every* specification right down to the finest detail.

The *Forrestal* – like the *USS Nautilus*, the first nuclear-powered submarine – is another striking example of where Walworth engineering and products were called upon to protect a multimillion dollar investment.

Walworth, backed by 113 years of practical valve experience, is skilled in every type of installation. Whatever the industry, if your problem concerns valves or fittings, it will pay you to call on Walworth! Distributors in principal cities throughout the world.



Here's Help in Understanding STEAM-WATER CYCLE ANALYSES

OFTEN, constituents of deposits in steam-water cycles are reported to you in mineral names rather than chemical formulas. To help you better understand reports and analyses with these names, Allis-Chalmers has published a new Informational Bulletin, Number 59. It lists each mineral, then gives the chemical formula, the usual area in which these deposits are found, and the causes and possible preventive measures you can take.

Part of Practical Library

Only careful analysis of all the factors in the cycle can solve a specific water problem. This bulletin will help you understand, generally, the causes and solutions of a variety of water problems. It is one of a series published by Allis-Chalmers. These bulletins reflect Allis-Chalmers wide experience from years of solving water problems in every industry, in addition to solving problems involved in the company's own broad line of power plant equipment.

ALLIS-CHALMERS WATER CONDITIONING
Equipment — Chemicals — Service

Complete Water Conditioning Service

Allis-Chalmers offers complete water conditioning service. You can get analyses and reports on your problems. You can get chemicals needed for water treatment. And you can get the equipment needed for any system.

For your copy of Informational Bulletin 59 explaining the mineral names used in analyses, write Allis-Chalmers, Milwaukee 1, Wisconsin. Or better, call your nearby A-C office to have an Allis-Chalmers water conditioning engineer consult with you on your problem. A-4414

Complete investigative facilities at Allis-Chalmers research laboratories include this X-ray diffraction unit which is used to analyze crystalline structure of deposits from steam-water cycles.

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

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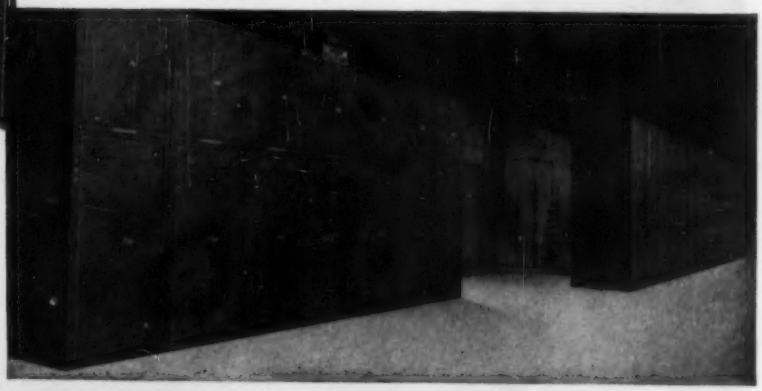
Oil Immersed

HIGH VOLTAGE
ACROSS-THE-LINE AND REDUCED VOLTAGE CONTROL OF CUBICLE CONSTRUCTION

Standard units consist of: insulated round bus with terminals for incoming line; low voltage control transformer; current limiting, high interrupting capacity fuses; quick acting, heavy duty contactor with non-freezing contacts; magnetic overload relays with instantaneous and inverse time element electrically reset; sealed-off motor terminal compartment; low voltage control center; self-contained tank lowering device; electrical and mechanical door interlock. Additional features such as watt-hour meter, voltmeter, ammeter, potential switch, etc., may be provided to meet the requirements of specific applications. These self-contained, self-supporting control units are designed for single or group mounting—for indoor or outdoor service.

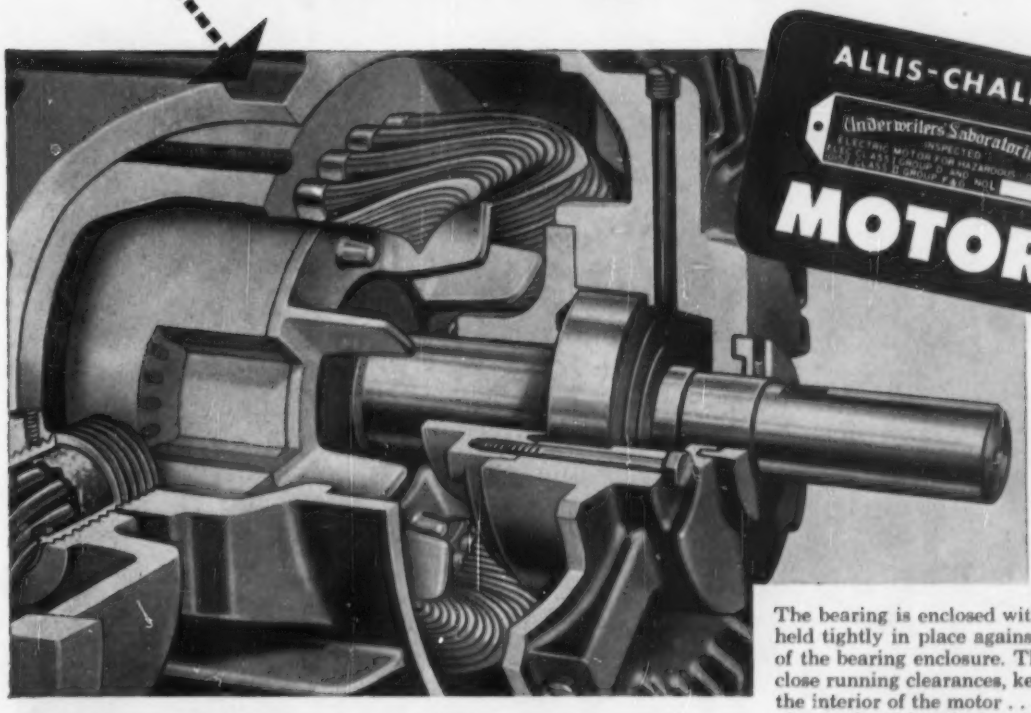


ABOVE — Type 700-B, high voltage combination starter of Cubicle construction. RIGHT—Group mounting of high voltage Cubicles shown in actual use.

ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.

Get Both bearing features



The bearing is enclosed with a bearing cap held tightly in place against the inner face of the bearing enclosure. This cap, with its close running clearances, keeps grease from the interior of the motor . . . retains an ample supply within the bearing enclosure.

At the outer side of the bearing, double labyrinth seals keep grease in, also keep dirt out. What's more, large grease reservoirs act as additional dirt traps.

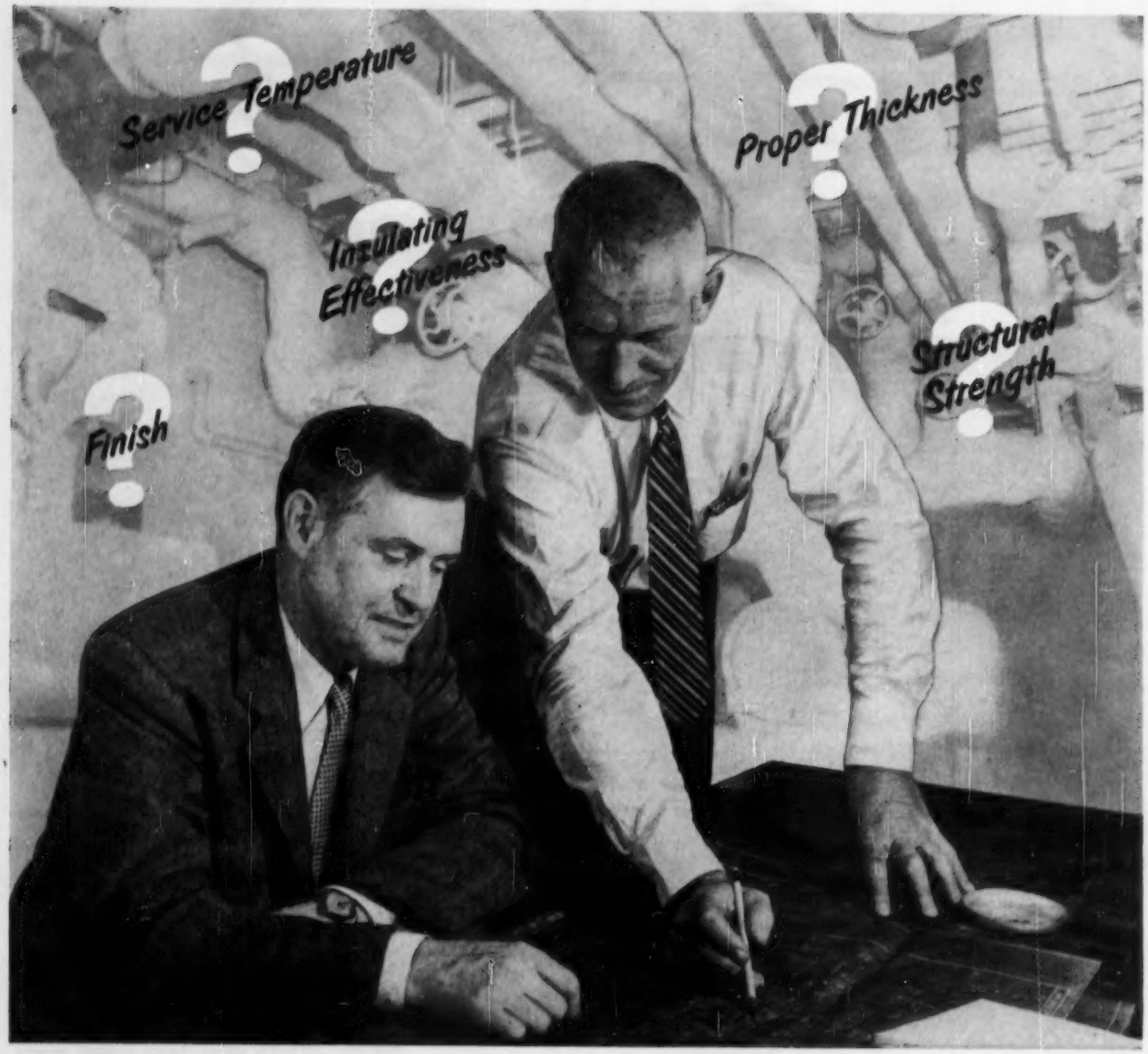
fully enclosed and protected . . . yet easy to grease

You can lubricate the bearings without dismantling the motor. Pipe-tapped holes in the bearing housings at three points provide both means for inserting new grease and a means of flushing out old grease.

Look for the extra bolts on the end housing . . . the sign of greater value. Ask your Allis-Chalmers representative or Authorized Distributor to show you a cutaway section of this maintenance-cutting design. Or write Allis-Chalmers, Milwaukee 1, Wisconsin, for Bulletin 51B7286.

A-4610

ALLIS-CHALMERS



Old hands at solving new insulation problems

Your **J-M Insulation Contractor** knows the answers that give you a better, more economical job

To be sure of getting the most efficient insulation for your plant or equipment, see the man with the world's most complete engineering and application service. He's your J-M Insulation Contractor who brings to every job the accumulation of Johns-Manville's 95 years' experience in the thermal insulation field.

J-M Insulation Engineers work hand in hand with J-M Insulation Contractors. Together they have achieved outstanding results with some of the most intricate insulation problems . . . of every type and size—in every industry.

J-M Insulation Contractors provide a complete selection of Johns-Manville quality materials. They will choose from their own stocks the best insulation for your conditions within the broad temperature range extending from minus 400F to plus 3000F.

Skilled application is a major contribution your J-M Insulation Contractor brings to every insulation job. His skilled mechanics have mastered the latest application techniques that assure you top-quality installation . . . give maximum operating economy and lower maintenance costs.

For undivided responsibility on all your insulation requirements, call your J-M Insulation Contractor. Write for the name of the one nearest you. Address Johns-Manville, Box 60, New York 16, New York. In Canada, Port Credit, Ontario.

JM PRODUCTS

Johns-Manville *first in* INSULATION

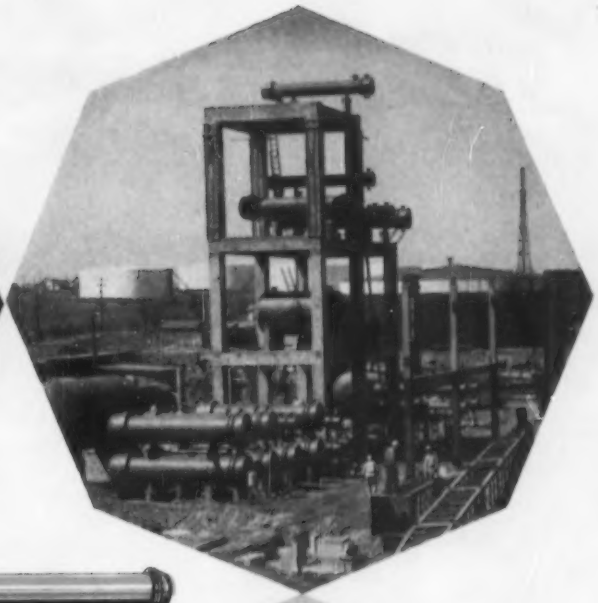
MATERIALS · ENGINEERING · APPLICATION

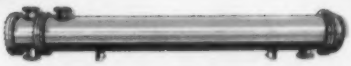
For more data on advertised products, use Readers' Service Cards, last page.

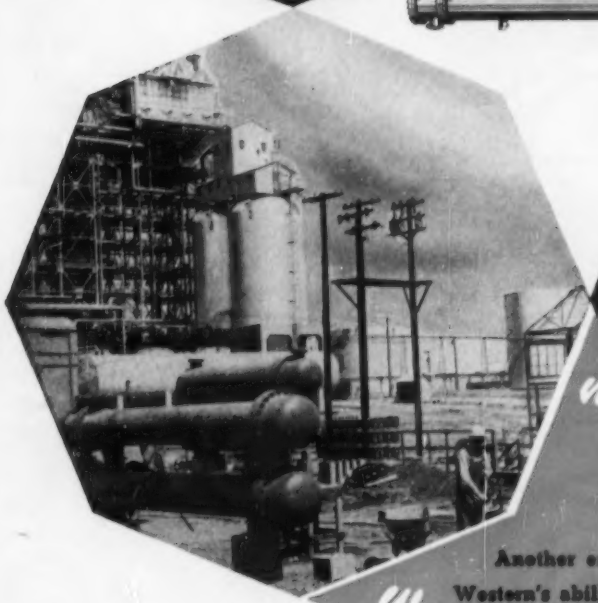
SUNRAY

NATURAL POWER

OILS







Another example of Western's ability to deliver . . . on time!

Shown above are Western heat exchangers installed in the Coking Unit superstructure at Sunray's Duncan, Oklahoma refinery. These photographs need no further explanation to men familiar with construction schedules.

Within a period of 8 weeks Western delivered all of the exchangers for The Lummus Company-built Coking Unit. . . The Refinery Engineering Company-built Platforming Unit. . . plus 19,000 square feet of Main Column Condensers for the Universal Oil Products Cat-Cracker.

For this one Sunray investment program — 46 heat exchangers from Western Supply Company aggregating a half million dollars worth of equipment.

WESTERN

HEAT EXCHANGERS

WESTERN SUPPLY COMPANY

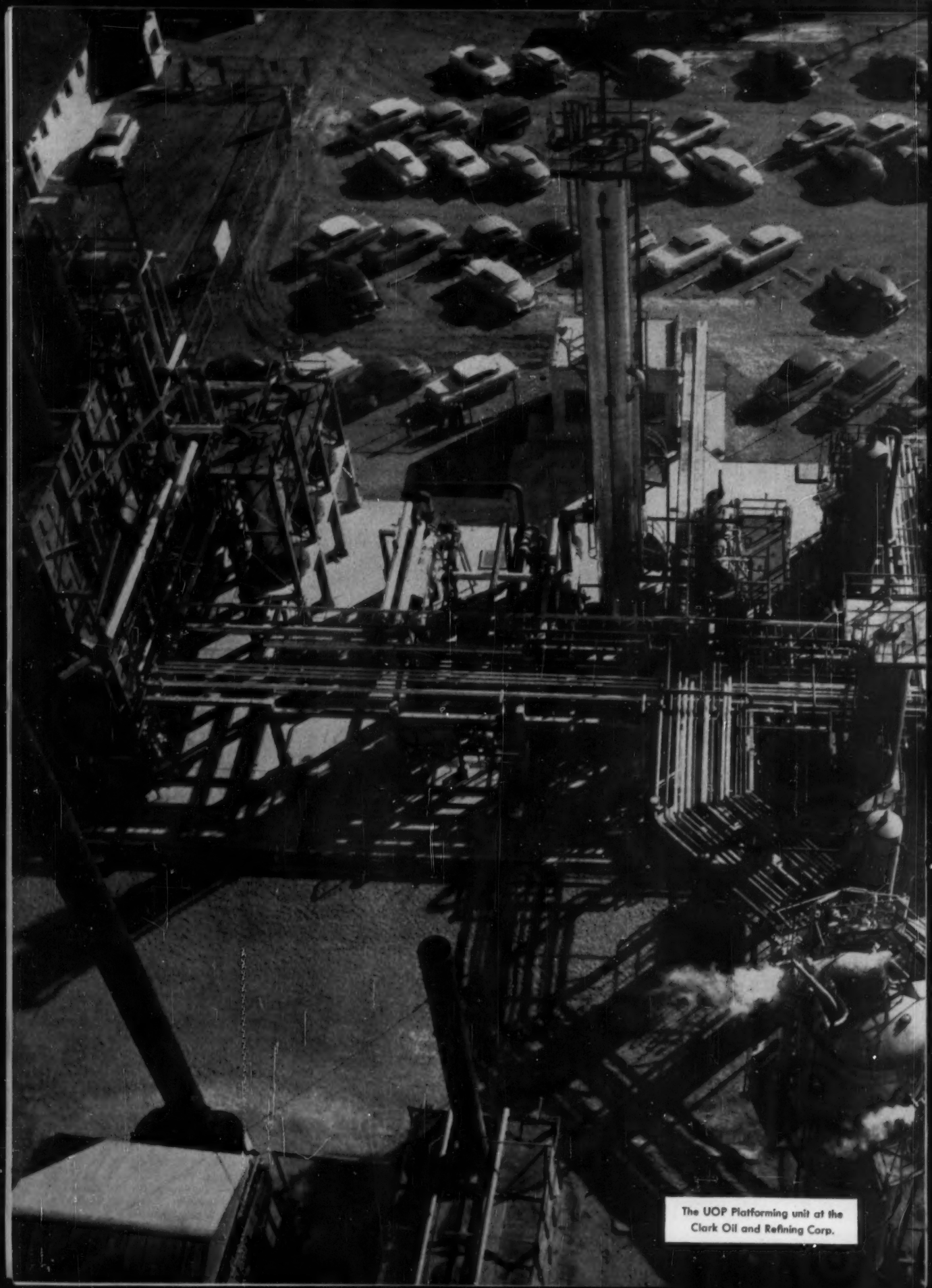
P. O. BOX 1888 • TULSA, OKLAHOMA

HUDSON-RUSH COMPANY—753 Gladstone Blvd., Shreveport, La.
130 Casa Linda Plaza, Dallas 18, Texas

PROCESS INSTRUMENTS & EQUIP. CO. - North Bldg., Charleston, W.Va.

H. W. SEVERANCE - 702 Marion E. Taylor Bldg., Louisville 2, Ky.

For more data on advertised products, use Readers' Service Cards, last page.



The UOP Platforming unit at the Clark Oil and Refining Corp.

Clark Oil and Refining Corporation Finds Platforming Valuable in Producing High Octanes

By John Stackner
General Manager
Clark Oil and Refining Corporation, Milwaukee, Wis.

THE UOP Platforming process, installed recently at our Blue Island, Ill., refinery, has made it possible for Clark Oil and Refining Corporation to assume a leading role in marketing high octane motor fuel in the Chicago area.

John Stackner

We are at present marketing a finished gasoline of 96 plus leaded octane, which is one of the top quality motor fuels being sold in the Chicago area. This is being sold as our new "Platinum Powered Clark Super 100 Gasoline," and it is produced in our Platformer. However, the unit will produce higher octane gasoline if needed. In fact, on test runs, the Platformer has produced 100 leaded octane motor fuel without temperatures being pushed to the design limit.

Aside from assuring us of sufficient octanes for some time to come, the Platforming process has permitted us to greatly expand our retail marketing program by making available an adequate supply of the best quality gasoline.

Closely tied in with the start up of the Platforming unit last November was the opening of 27 new, modernistic service stations in the Chicago area, marking the first time that Clark has invaded this particular gasoline marketing field. Almost simultaneously, more than 100 other retail outlets in several states, which had been flying the banner of other independent companies, were acquired by our company, and began to sell the new "Platinum Powered" gasoline for the first time in their areas. Clark now has more than 325 retail outlets in eight states—Illinois, Indiana, Michigan, Wisconsin, Minnesota, Iowa, Kansas and Missouri—an increase of approximately 100 per cent in little more than a year.

Can Produce Only Premium

The Platforming process has also given our Blue Island refinery the distinction of being one of the few in the Chicago area able to produce only premium motor fuel. We are in this enviable position because the Platformer can adequately handle the refinery's entire output of straight run gasoline without any of it being diverted to the production of less profitable materials. This of course reflects favorably on the increased profitability of the overall refinery operation.

The Platforming unit has a design capacity of 5,500 barrels per day, and it is currently operating at two-thirds of capacity in handling the crude unit's entire production of straight run gasoline. But a capacity operation can be assured by drawing upon additional supplies of straight run from the company's other refinery at Marrero, La., a suburb of New Orleans. However, an increase in the capacity of the Blue Island plant's crude topping unit from 16,000 B/SD to 20,000 B/SD will make it unnecessary to ship charge stock from Marrero for full capacity operation.

Another important advantage which has accrued to Clark through installation of the Platforming process has been the increase in the production of premium gasoline. Under our previous operation, the refinery's daily production of 93 leaded octane premium ranged from 50 to 55 per cent of the total gasoline made. With the Platformer, the production of premium has risen in excess of 90 per cent of the total gasoline output, and the octane has been increased to 96 plus.

Extensive Modernization Program

An extensive refinery modernization and expansion program was centered around installation of the Platformer, which was designed, engineered and licensed by Universal Oil Products Company. The unit was built by Procon Incorporated in about six months. We also are planning to convert one of two existing thermal reformers, which are now shut down, to a thermal cracking unit in order to supplement the yield of gasoline from a 7,500 B/SD catalytic cracking unit.

We regard Platforming as one of the greatest developments ever made in the refining field. The process has enabled Clark to become a leader in marketing top quality motor fuel in the highly competitive Chicago area. The public response to our new "Platinum Powered" Clark Super 100 gasoline has resulted in one of the biggest upswings in business in our 21-year history.

CLARK TAKES A LEADING ROLE IN MARKETING HIGH OCTANE GASOLINE WITH UOP PLATFORMER

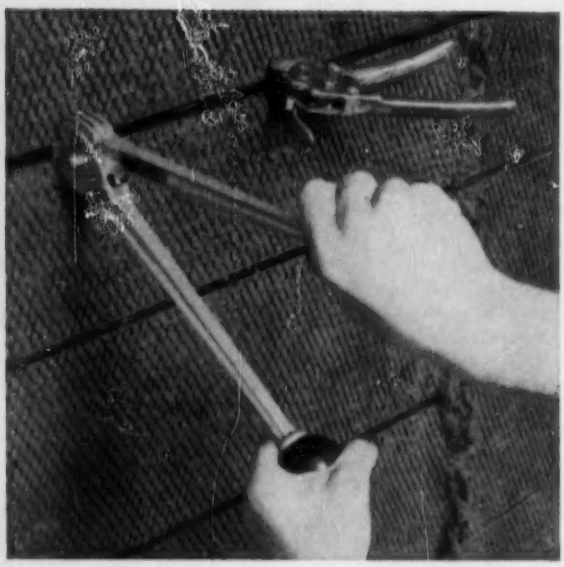
designed, engineered and licensed by

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD,
DES PLAINES, ILL., U. S. A.
Laboratories: RIVERSIDE, ILLINOIS

Universal Service Protects Your Investment

EAGLE-PICHER
BLANKET INSULATION
FACTORY FABRICATED to rigid specifications



FACTORY FABRICATION is your assurance Eagle-Picher Blankets are completely free of large "voids" usually found in field made blankets where insulation is simply packed in place. Because they're uniform these blankets can be tightly butted together to eliminate cracks and loose joints.

FACTORY FABRICATED to rigid specifications is your assurance that copper bearing steel laths, bound by uniformly spaced soft-drawn galvanized tie wires, keep the blankets firm but flexible. They can be quickly applied to flat or slightly curved surfaces on any large heated equipment—or cut to fit irregular areas.

FACTORY FABRICATED to rigid specifications means that *every* blanket is made up of many layers of Eagle-Picher mineral wool uniformly dispersed over the entire area of each blanket. The outstanding chemical and physical characteristics of Eagle-Picher mineral wool provide maximum thermal efficiency at temperatures as high as 1200 F.

WRITE FOR FREE SAMPLE TODAY!

Prove to yourself that Eagle-Picher Blankets are factory fabricated to meet your own exacting standards!

Since 1843

EAGLE EP PICHER

THE EAGLE-PICHER COMPANY

Producing a complete line of industrial insulations

Cincinnati 1, Ohio

(Member of Industrial Mineral Fiber Institute)

(Conforms to Commercial Standard CS 117 and Federal Specification HH-I-563)

GEWERKSCHAFT ERDÖL-RAFFINERIE EMSLAND, GERMANY

The Houdriflow catalytic cracker of the Gewerkschaft Erdöl-Raffinerie Emsland, at Lingen, Germany, is the principal unit in a completely new refinery. This 17,500 BPSD cracker went on stream in the Fall of 1953.

The Emsland Houdriflow cracks straight run and coker gas oils and, in addition, desulphurizes the straight run and coker gasoline simultaneously. No crude distillation unit exists at this refinery; the Houdriflow feed stock comprises all flashed straight run materials from the crude as well as total coker effluent—gas, gasoline and gas oil. This arrangement eliminates intermediate storage equipment and reduces operating costs.

For a new brochure describing the Houdriflow process, write: Houdry Process Corporation, 1528 Walnut Street, Philadelphia 2, Pennsylvania.

HOUDRY

PROCESS CORPORATION

Pioneer in Catalytic Processes

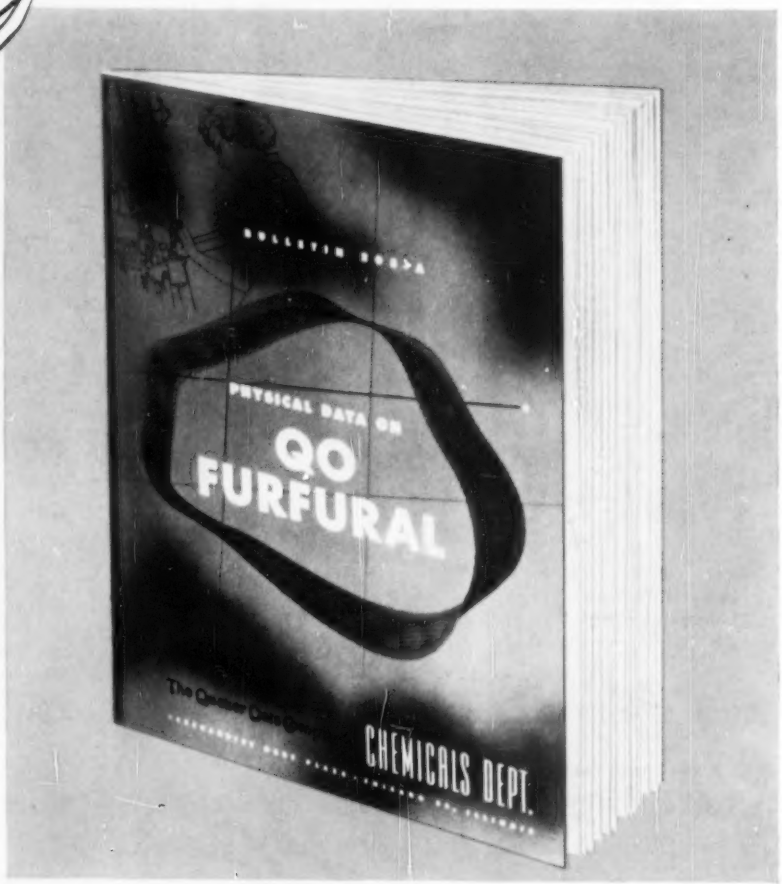
write for:

NEW QUAKER OATS' BULLETIN 203-A

physical data on QO® FURFURAL

This bulletin—just published—includes graphs and tables of the physical properties of QO Furfural. In addition, the recovery of furfural for re-use in continuous processing is described.

To help you evaluate QO Furfural as a selective solvent for lubricating oils, gas oil, catalytic cracker recycle stock, butadiene and other processes, write for your copy of 203-A.



The Quaker Oats Company — **CHEMICALS DEPT.**

340K The Merchandise Mart, Chicago 54, Illinois
Room 540K, 120 Wall St., New York 5, N. Y.
Room 440K, P. O. Box 4376, Portland 8, Oregon

In the United Kingdom: Imperial Chemical Industries, Ltd., Billingham, England • In Europe: Quaker Oats-Graanproducten N.V., Rotterdam, The Netherlands; Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France; A/S "Ota", Copenhagen, S. Denmark
In Australia: Swift & Company, Pty., Ltd., Sydney • In Japan: F. Kanematsu & Company Ltd., Tokyo

SAFETY

is a vital part of our construction service

Several factors combine to make a Blaw-Knox Chemical Plants Division construction job move smoothly, speedily, to a trouble-free completion. One of these is *safety* in construction activities.

Here the Chemical Plants Division has an outstanding record, which is recognized by safety awards such as these:

- **Associated General Contractors of America**
  14,090,000 man-hours awarded 1953 *First Place* in Group A, which covers all member contractors doing over 500,000 man-hours of work annually.
- **National Safety Council Awards of Honor**
  (for work without a lost-time accident)

  4,112,095 man-hours for the DuPont Company at Charlestown, Indiana, from December 1952 to May 1953.

  1,649,574 man-hours for the Atomic Energy Commission at the Hanford Ordnance Works, Richland, Washington, from September 1953 to January 1954.

  1,233,097 man-hours also at Hanford Ordnance Works, between July and September 1954.

But safety at Blaw-Knox does not start or end with construction. Safety provisions on all Chemical Plants Division projects are made a most important part of every stage of planning, designing and selecting of materials and equipment, and they extend beyond the period of construction. Safety records in plants designed and erected by our engineers, as an example, are among the best to be found anywhere.

Chemical Plants Division is the engineering-constructing organization of the Blaw-Knox Company which designs and builds plants for many industries, including chemicals, detergents, drugs, fats and oils, fertilizers, foods, gases, low temperature, nuclear energy, petroleum, petrochemicals, resins and plastics, synthetics and wood utilization. Let us help you solve your planning, engineering and construction problems . . . on all or any part of your project.

BLAW-KNOX

BLAW-KNOX COMPANY
Chemical Plants Division
Pittsburgh 22, Pennsylvania
Tulsa 1, Oklahoma/Chicago 1, Illinois

For more data on advertised products, use Readers' Service Cards, last page.

STOP Shutdown!

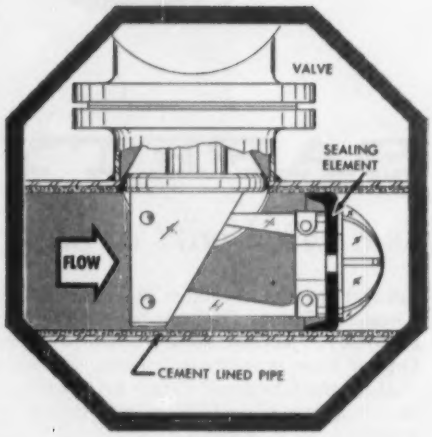
WmSON STOPPLE plugs vital 14" water line... permitting repair without shutdown

SHUTDOWN OF ENTIRE WATER COOLING SYSTEM, SERVING PROCESS UNITS OF A NEW JERSEY REFINERY WAS AVOIDED BY USE OF A STOPPLE

PIPING diagram showing how a leak was repaired while STOPPLE isolates downstream section.

PROCEDURE

1. **FLANGED** nipple welded to pipe. Hole cut with WmSON-HILLCO tapping machine.
2. **STOPPLE** installed, making complete seal in pipe, isolated the section to be repaired.
3. **REPAIRS** were made while upstream units continued to operate.
4. **STOPPLE** removed, repaired section put back into operation.



CUT-AWAY VIEW OF STOPPLE SEALING ELEMENT

Experienced Williamson representatives, factory-trained, will assist you in the proper use of Williamson STOPPLES and Tapping Machines.

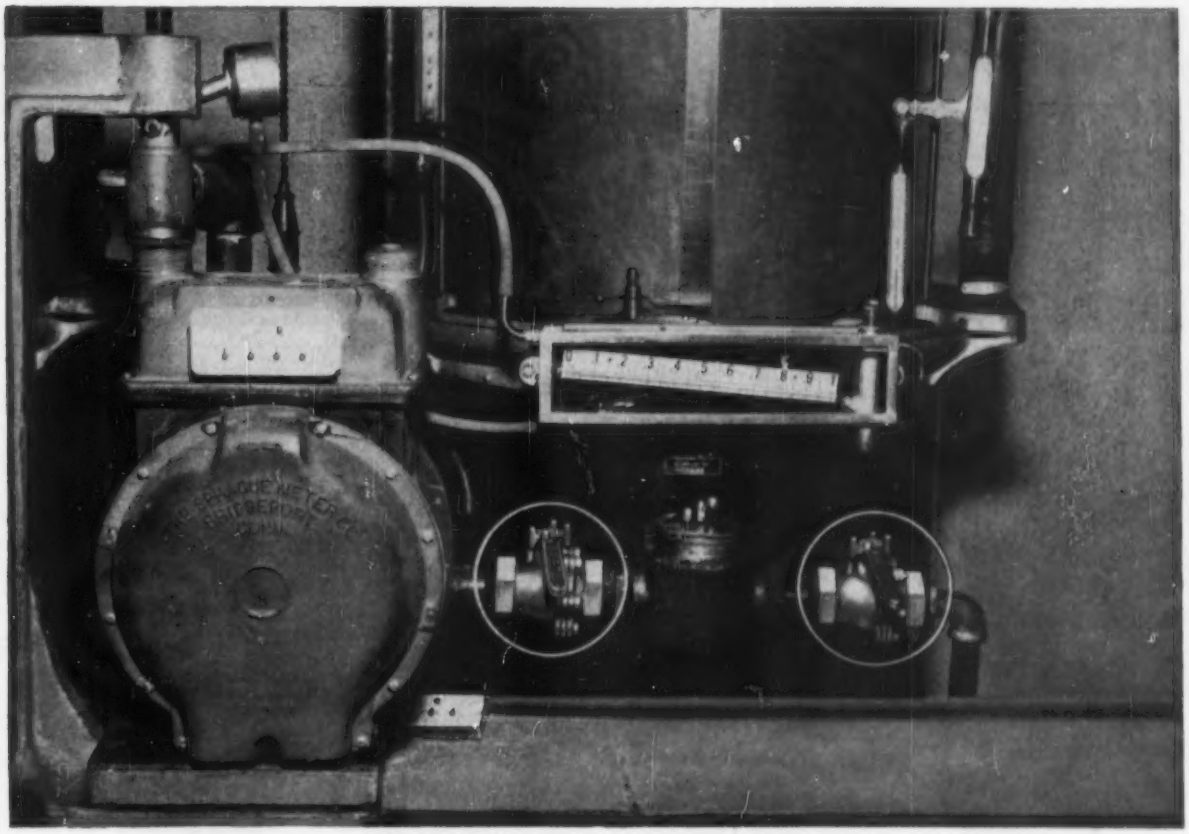
STOPPLES may be rented or purchased
STOCK SIZES: 4" 6" 8" 10" 12" 14" 16" 18" 20" 22"
ALL TESTED TO 800 PSI. OR 1,000 PSI.

Write For Literature

T.D. Williamson, Inc.

P. O. BOX 4038 • TULSA 9, OKLAHOMA

REPRESENTATIVES Houston • Pittsburgh • Kenilworth, N. J. • Amarillo • Casper • Provo, Utah • Joliet, Illinois • Los Angeles • San Francisco • Bartlesville, Okla. • Edmonton • London, Ontario • Calgary • Buenos Aires • Durban, Natal, South Africa



Handling Air Under Pressure – These Valves Open, Close . . . 1000 times a day!

The Sprague Meter Company, Bridgeport, Connecticut, uses Rockwood Ball Valves in air lines testing gas meters.

One thousand times a day, the valves are opened and closed. Yet they have completed two years' steady service without leakage, without maintenance!

This leakproof trouble-free performance is typical of the way in which Rockwood Ball Valves handle everything from L. P. G. to pickling acids, alcohol to asphalt. Used throughout the petroleum field, their efficiency stems from these four exclusive features —

Full Round Flow — no change in shape or volume of fluid stream — no turbulence — no minimum loss

Quick Opening and Closing — only a quarter turn needed

Longer Wear-Resistance — chrome-plated bronze ball withstands abrasion, pitting and scratching

Leakproof Seal — pressure of fluid automatically positions ball against seat to form tight seal.

If you are not now using Rockwood Ball Valves, send coupon today for complete information. Valves come in all pipe sizes. Tested and listed by Underwriters' Laboratories, Inc.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
782 Harlow Street
Worcester 5, Mass.

Send me illustrated folder V-4 on Rockwood Full-Flow Ball Valves.

Name_____

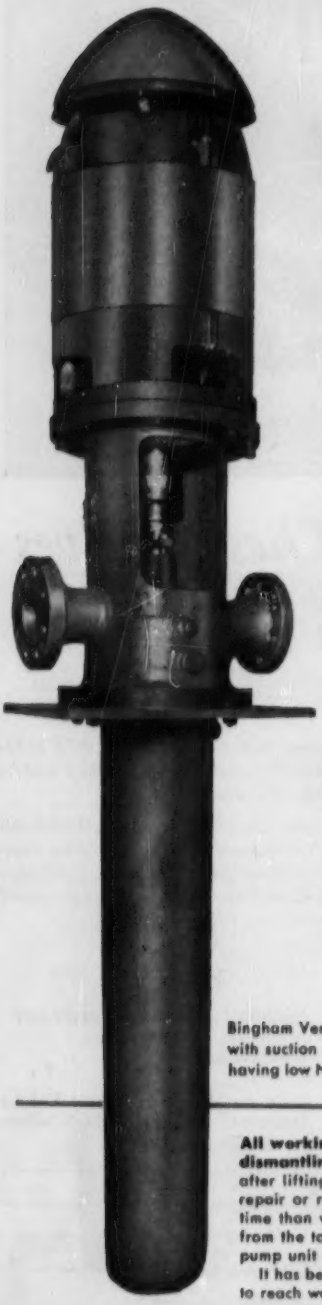
Title_____

Company_____

City_____

Zone_____ State_____

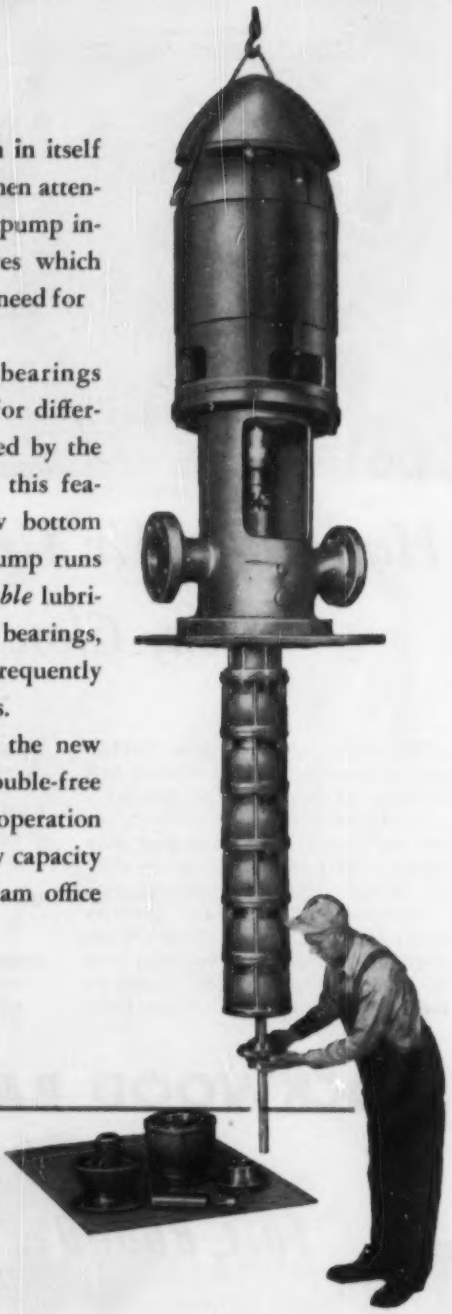
NEW! Bingham ALL WORKING PARTS



Besides bottom dismantling, which in itself greatly reduces maintenance time when attention is required, this new Bingham pump incorporates advanced design features which minimize maintenance, reducing the need for periodic inspection.

For example, all intermediate bearings (supplied of appropriate material for different pumpages) are forced-lubricated by the pumpage. Diagram at right shows this feature and, in addition, shows how bottom bearing is lubricated even if the pump runs dry for short periods. This *dependable* lubrication greatly prolongs the life of bearings, which in conventional pumps are frequently the cause of maintenance shutdowns.

Wherever it has been installed, the new Bingham VCP Pump has given trouble-free service—plus unsurpassed smooth operation with no vibration. Available for any capacity or head. Write your nearest Bingham office for additional information.



Bingham Vertical VCP assembled with suction well for installations having low NPSH conditions.

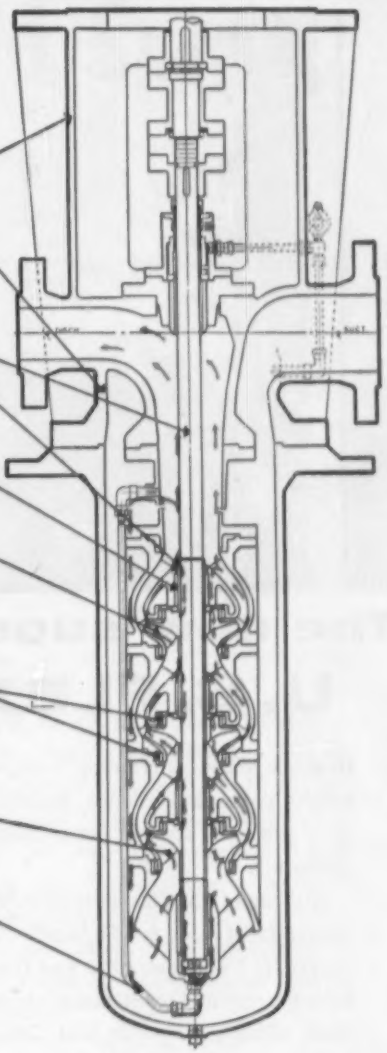
All working parts of pump easily accessible with bottom dismantling. One man can service the Bingham VCP Pump after lifting pump from well. By dismantling from the bottom, repair or replacement of any part can be made in much less time than with conventional pumps (where dismantling begins from the top, necessitating removal of driver and head before pump unit is accessible).

It has been estimated by various operators that time required to reach working parts has been reduced as much as 50%.

VCP VERTICAL PUMP FOR LOW NPSH
ACCESSIBLE WITH BOTTOM DISMANTLING

ONLY *Bingham* OFFERS ALL THESE BENEFITS:

1. Heavy-duty steel suction and discharge head rigidly built to eliminate vibration caused by drivers.
2. Shaft is maximum diameter throughout.
3. Shafts are equipped with renewable 11-13 chrome, hardened, ground and polished sleeves at each bearing.
4. Bearings are of the appropriate material for the different pumpages.
5. Maximum head per stage and maximum efficiency for a given capacity range.
6. Front and back wearing rings on enclosed type impellers permit a one-stage pressure drop over each bearing for lubrication purposes.
7. Wear rings reduce thrust of rotating element, permitting use of standard motors.
8. Maximum eye area of bottom impeller for lowest possible NPSH.
9. Bottom bearing lubricated by pumpage taken from the discharge column, which, together with connecting pipe, acts as a reservoir for bearing lubrication in event pump operates "dry" for short periods.



Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY
***General Offices:* 2800 N.W. Front Avenue, Portland 10, Oregon**
***Factories:* Portland, Ore. • Vancouver, B.C., Canada**

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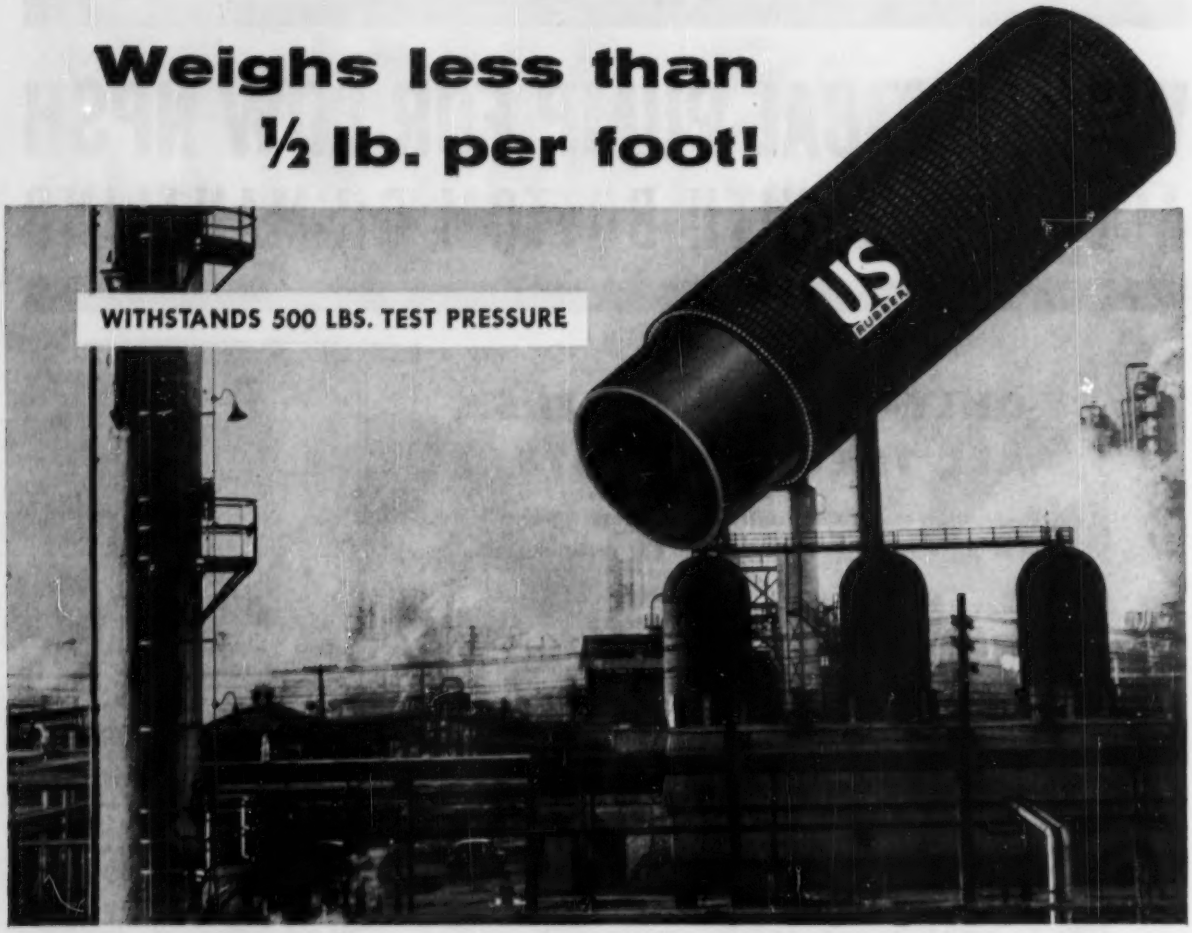
For more data on advertised products, use Readers' Service Cards, last page.

Weighs less than ½ lb. per foot!



The new super-flexible *All-Dacron*

U. S. FLEXLITE® FIRE HOSE!

Its single jacket is all Dacron*—to give the lighter weight, pressure resistance, flexibility, rackability required by today's petro-chemical fire departments.

Although U. S. Flexlite weighs 50% less than conventional hose, it will handle extreme pressures! Its Neoprene tube and Dacron jacket have the required resistance to chemicals, petroleum, mildew, dampness, heat. Coils easily, dries fast. United States Rubber Company also makes the following hose for the petro-chemical field.

(1) "Reliance®" Double Jacket Dacron reinforced (weighs 50 lbs. per 100 ft.) (withstands 400 lbs. test pressure)

(2) "Reliance" Double Jacket Dacron reinforced (weighs 54 lbs. per 100 ft.) (withstands 600 lbs. test pressure)

(3) U. S. Matchless® Carbolized—most rugged hose in the market.

Get in touch with any of our selected distributors or any of the 27 "U. S." District Sales Offices.

*DuPont's polyester fiber

"U. S." Research perfects it..."U. S." Production builds it...U. S. Industry depends on it.

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

Fittings stay fastened in Corrosive Acid Spray

PROBLEM:

Selecting fastenings that would hold pipe fittings together in a unit that is constantly subjected to a hot sulphuric acid spray. Bolts were formerly falling apart in four months' time.

REMEDY:

Use of nuts and bolts made of wrought HASTELLOY alloy C.

RESULT:

Fastenings made of HASTELLOY alloy C are still holding many months after ordinary bolts had to be replaced.

HASTELLOY alloy C is the most universally corrosion-resistant alloy available today. In addition to aerated sulphuric acid, it has excellent resistance to such strong oxidizers as nitric acid, wet and dry chlorine, and acid solutions of salts. It is available in nearly all standard commercial forms.

For more information on HASTELLOY alloy C, get in touch with the nearest Haynes Stellite Company Office.

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

UCC

General Offices and Works, Kokomo, Indiana

Sales Offices

Chicago • Cleveland • Detroit • Houston • Los Angeles • New York • San Francisco • Tulsa

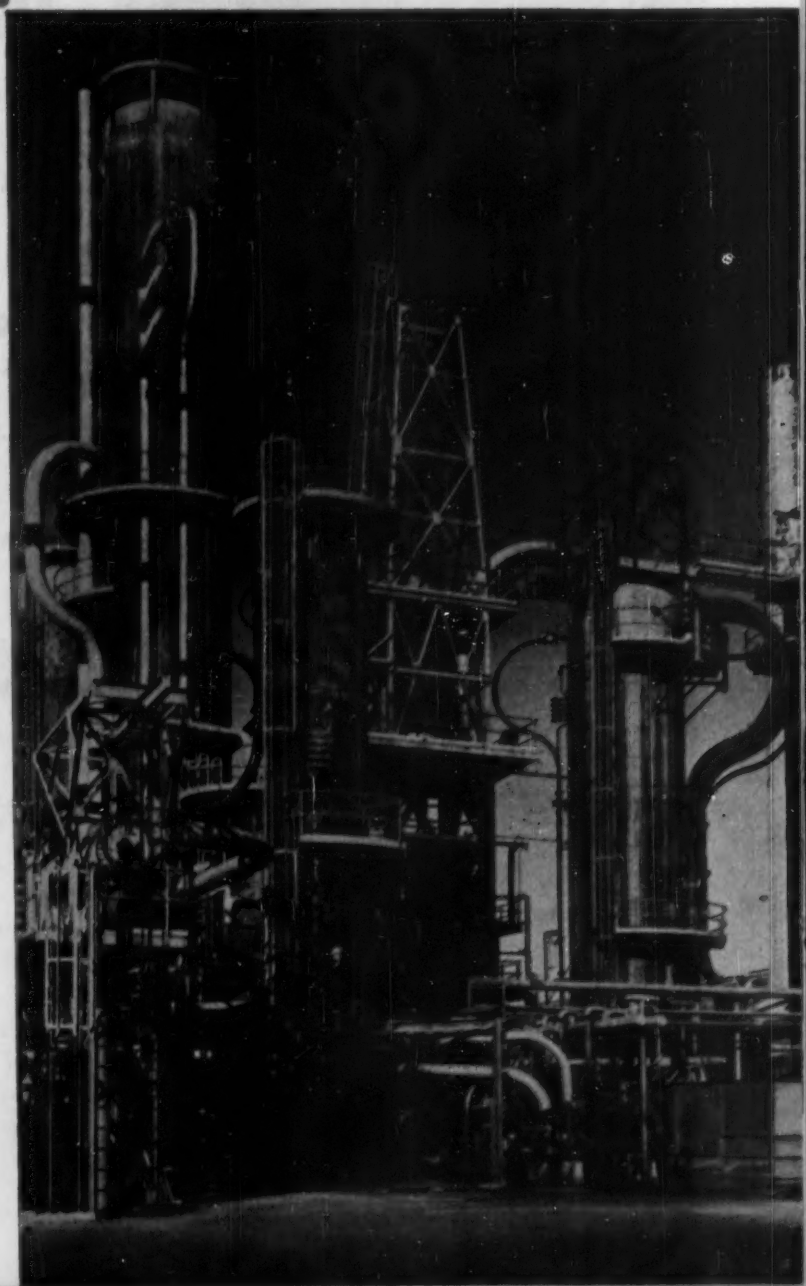
"Haynes" and "Hastelloy" are registered trade-marks of Union Carbide and Carbon Corporation

10 REASONS WHY

LEADING REFINERS RELY ON KONTOL FOR PROTECTION AGAINST CORROSION

1. Kontol protects against attack by organic and inorganic acids and brines which cause corrosion, hydrogen blistering and embrittlement.
2. Kontol effectively protects steel, nickel and stainless alloys of steel, monel, brass and admiralty metal.
3. Kontol offers detergent action as well as inhibitive properties. It also assures the advantages of operations with clean units and flow systems.
4. Kontol has no adverse effects on distilled product properties such as distillation end point, gum formation, anti-knock rating, ash, etc.
5. Compared with the replacement costs of the equipment it protects, the cost of Kontol protection is negligible.
6. Kontol is convenient and safe to handle, easy to apply. No gloves, masks, goggles, aprons or extraordinary safety precautions are necessary.
7. Kontol is available in many formulas, to meet varying requirements. It can be oil soluble; oil soluble and water dispersible; water soluble and oil insoluble.
8. Kontol, in the appropriate formula, is miscible in all proportions with aqueous alkaline agents and can be injected through the same system.
9. The Tretolite commercial testing staff will carry on tests to determine the rate of corrosion in your refinery, at no cost to you.
10. Kontol has been proved to provide protection against corrosion in

CAT CRACKER FRACTIONATORS
CRUDE STILLS
DEPROPANIZERS
DEBUTANIZERS
DEPENTANIZERS
GAS RECOVERY SYSTEMS
ABSORBERS
STABILIZERS
PLATFORMERS
REFORMERS
DESULFURIZATION SYSTEMS
VACUUM TOWERS
ALKYLATION PLANTS
COKING SYSTEMS
DEWAXING SYSTEMS
ALKANOLAMINE SWEETNERS



TRETOLITE COMPANY
KONTOL
SAINT LOUIS · LOS ANGELES

DESALTING · CORROSION INHIBITING · WATER DE-OILING
DEMULSIFYING · SCALE PREVENTION · ASPHALT ADDITIVES

If you have a corrosion or fouling problem, get in touch with the Tretolite refinery service engineer in your area or write to

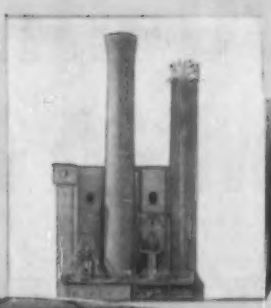
TRETOLITE COMPANY
A DIVISION OF PETROLITE CORPORATION

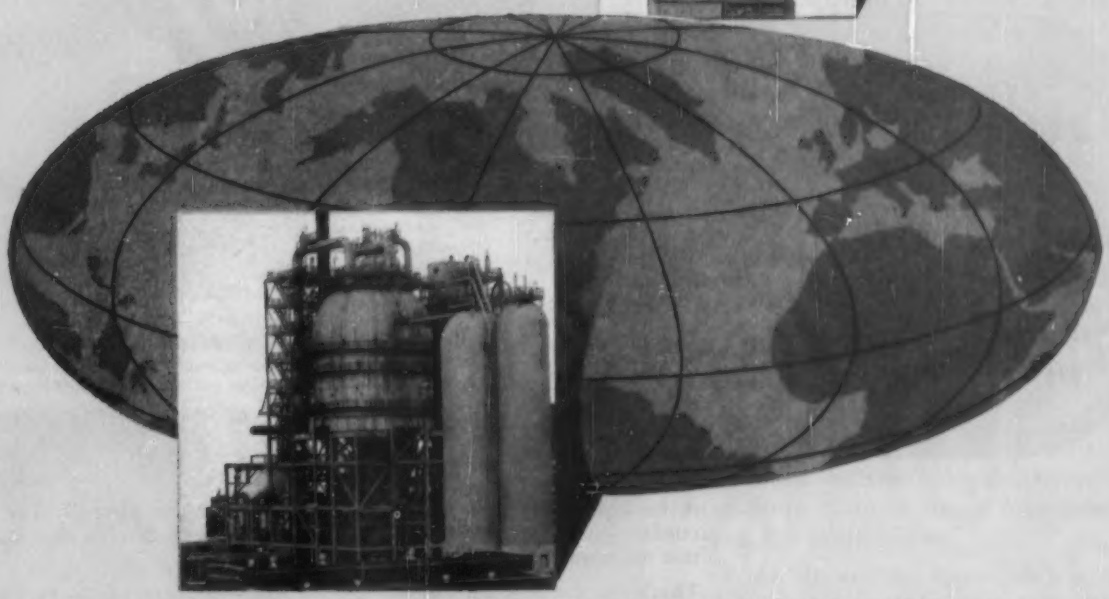
369 Marshall Avenue, St. Louis 19, Missouri
5515 Telegraph Road, Los Angeles 22, California

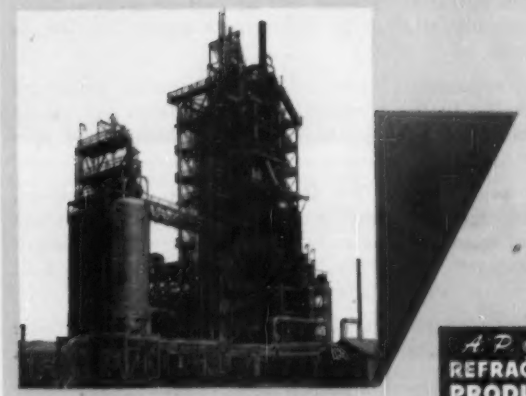
ALL OVER THE WORLD

A. P. GREEN

Serves the Refinery Industry with a Complete Line of High Quality Refractory Products







Throughout the world, the refinery industry relies on A. P. Green high quality refractories for dependable service in thermal and catalytic cracking units, heaters, boilers, stacks, etc.

A world-wide network of A. P. Green distributors is always ready to help you select the right refractories to do the best possible job . . . at the lowest cost. Regardless of location, A. P. Green refractories reach you quickly, safely, exactly as ordered.

A. P. Green REFRACTORY PRODUCTS

A. P. GREEN FIRE BRICK COMPANY
Mexico, Missouri, U. S. A.

PLANTS: Mexico, Mo. • Woodbridge, N. J. • Sulphur Springs, Texas
In Canada: **A. P. GREEN FIRE BRICK COMPANY, LTD.**
Toronto 15, Ontario

For more data on advertised products, use Readers' Service Cards, last page.

stainless steel, too, means more than a shining face

A healthy youngster's natural grin is "chromium plated" after a conflict with soap and water. But it's his all-the-way-through character that measures his ability to cope with problems.

That's the way it is with stainless steel. And—important fact—varying amounts of chromium and other metals can be alloyed with steel to give stainless the specific all-the-way-through character needed to meet special problems.

Sun Ship has earned a reputation for mastering many special problems in its decades of service to the chemical, petrochemical, petroleum and other industries which face problems in fabrication and specialized machinery.

Now, with its new segregated Alloy Products Shop in operation, Sun Ship is using its experience and precise workmanship to adapt the superb qualities of stainless steel and other alloys to the equipment needs of the many industries it serves. In this shop are fabricated all grades of stainless, alloy, and aluminum.

Our Sales Engineering Department will be glad to discuss the value of this shop and its products in meeting your specific problems.

Sun Ship also makes all types of carbon steel pressure vessels.

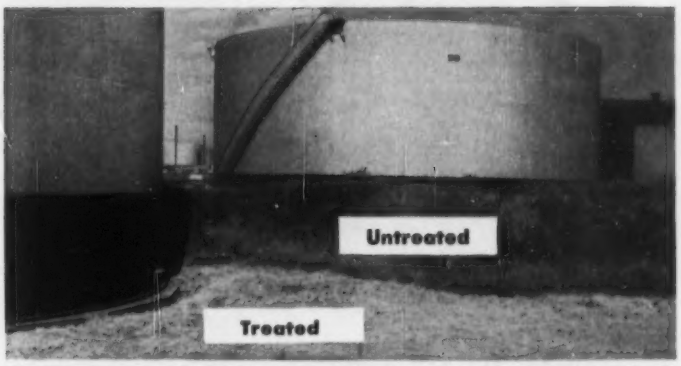
ALLOY PRODUCTS SHOP

OF Sun SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE • **CHESTER, PA.** • 25 BROADWAY, NEW YORK CITY

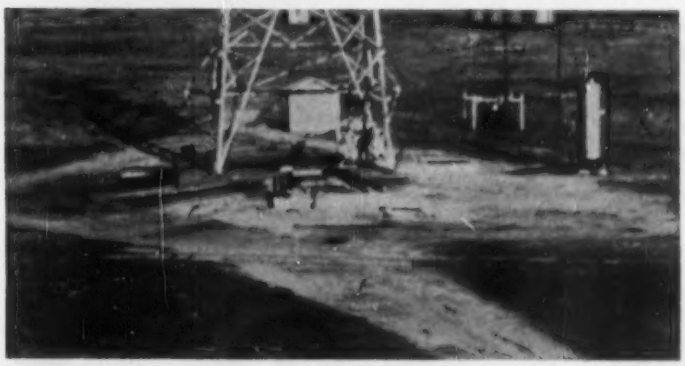
Weed and Brush Control lasts longer with Du Pont TELVAR® and AMMATE®

Weed Killers — *Weed and Brush Killer*



Fire hazards are reduced around oil storages from thorough, long-term weed control with Du Pont "Telvar." "Telvar" is non-corrosive, won't harm application equipment.

Heavy weed growth was controlled with one application of "Telvar." "Telvar" keeps pipelines and key areas accessible, efficient to work around.



"Telvar" is ideal for weed control around derricks, pumps, storages. "Telvar" is easy to apply; extremely low in toxicity to humans and animals; non-flammable; and non-volatile.

One application of "Telvar" solves weed problems for a season or longer!

"Telvar" kills through the roots . . . prevents regrowth. Low dosages (20 to 80 lbs. per acre) make it cost little for the results you obtain. Low rates also mean less handling, less storage facilities. If you're looking for a way to cut maintenance costs to new low levels, include "Telvar" in your weed-control program. Available in two formulations: "Telvar" W; and "Telvar" DW, which is especially suited for light, sandy soils and in areas where annual rainfall is higher than 20 inches.

"Ammate" kills more kinds of brush and keeps it down longer than most weed and brush killers!

When the original spray job is well done, brush is kept under control with nothing more than an occasional spot spray later. You can rely on "Ammate" to do the job safely, even where your rights-of-way adjoin crop land, because "Ammate" is not volatile. There are no vapors to drift onto sensitive crops.

FREE ILLUSTRATED BOOKLETS describe how to control weeds and brush with Du Pont chemicals. For your copies, write to Du Pont, Grasselli Chemicals Dept., Rm. D 4032, Wilmington, Del. In Canada—Du Pont Company of Canada Limited, Box 660, Montreal.

TELVAR® AMMATE®

Weed Killers — *Weed and Brush Killer*

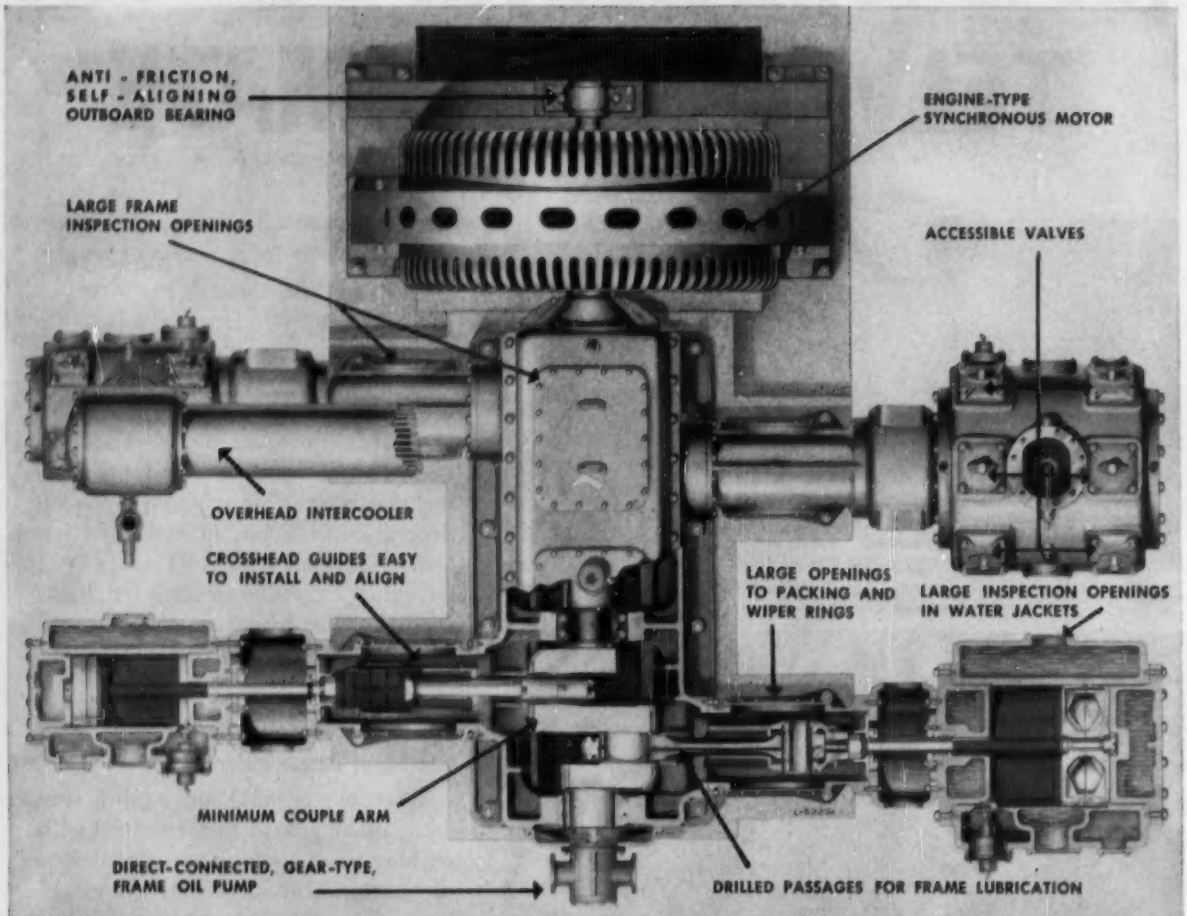
On all chemicals always follow directions for application. Where warning or caution statements on use of product are given, read them carefully.

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

Worthington Balanced Gives LOWEST OPERATING


ANTI - FRICTION, SELF - ALIGNING OUTBOARD BEARING
ENGINE-TYPE SYNCHRONOUS MOTOR
LARGE FRAME INSPECTION OPENINGS
ACCESSIBLE VALVES
OVERHEAD INTERCOOLER
CROSSHEAD GUIDES EASY TO INSTALL AND ALIGN
LARGE OPENINGS TO PACKING AND WIPER RINGS
LARGE INSPECTION OPENINGS IN WATER JACKETS
MINIMUM COUPLE ARM
DIRECT-CONNECTED, GEAR-TYPE, FRAME OIL PUMP
DRILLED PASSAGES FOR FRAME LUBRICATION

CUTAWAY OF FOUR CYLINDER BALANCED OPPOSED COMPRESSOR. Just one of the many multi-service cylinder arrangements available. Option of drivers gives full freedom in choice of power or fuel for maximum economy and convenience. Available drivers include: direct-connected engine-type synchronous motor *(shown);* steam turbine through reduction gear; special induction motor; or direct-coupled internal combustion engine. Red areas show lubrication coverage.

"Easier to inspect and maintain than any similar compressor." That's what engineers say about the Worthington Balanced Opposed Compressor.

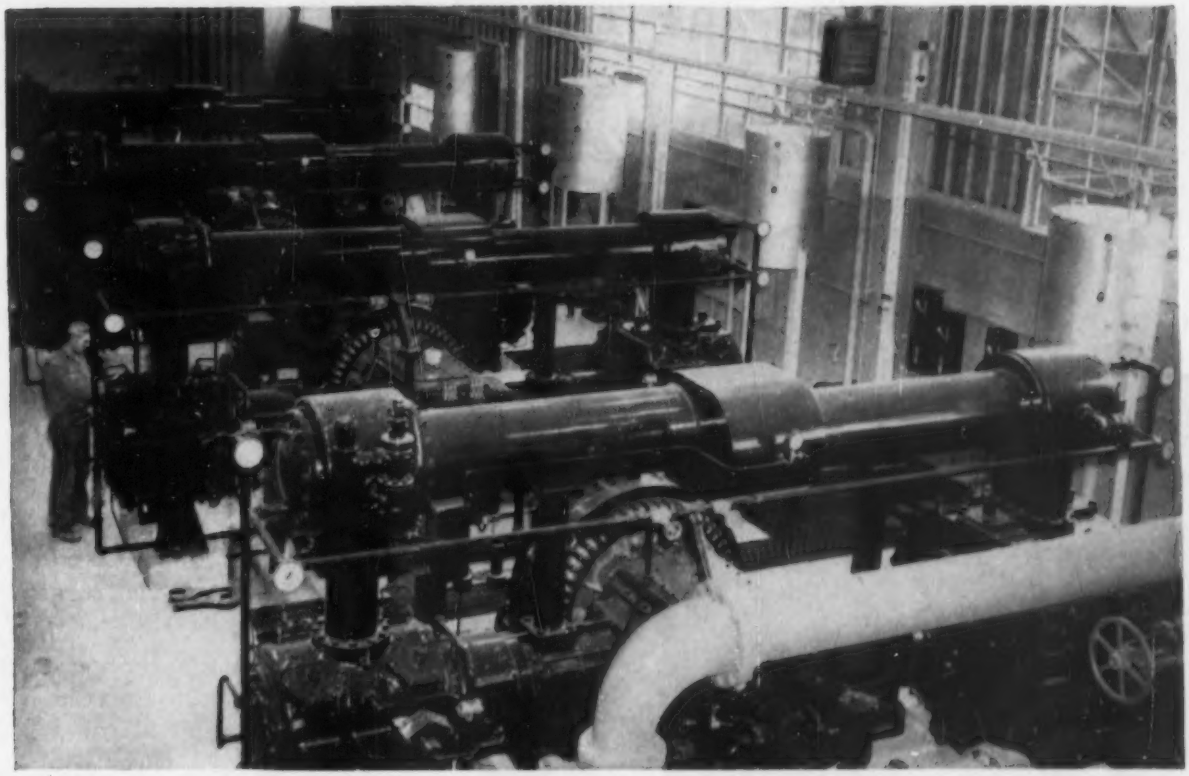
LARGE ACCESS OPENINGS are provided for inspection and maintenance of piston rod packing, oil wiper rings, water jacket, main bearings, crossheads, and crosshead guides. All valves are accessible and easily replaced. This easy accessibility of working parts facilitates *preventive* maintenance, reduces downtime for *corrective* maintenance.

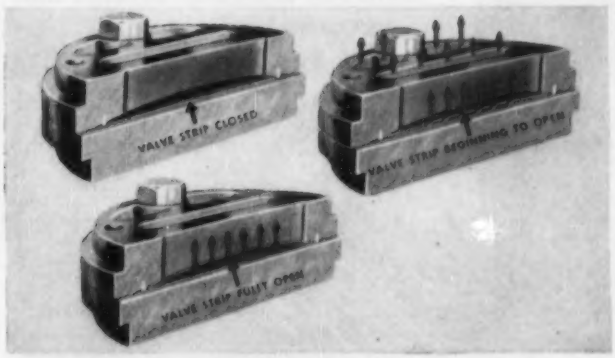
REDUCED INSTALLATION COSTS because foundations can be smaller. Inertia forces developed in one cylinder are bucked and largely cancelled out by similar and opposite forces developed in the opposing cylinder. Only a relatively small turning force, or couple is transmitted to the foundation. As a result, foundations are smaller for the balanced opposed than for equally rated compressors of other designs.

MAXIMUM STRENGTH, MAXIMUM STABILITY, result from the rugged one-piece-cast main frame and most stable construction of any similar compressor. Main bearing supports are integral with frame and reinforced with heavy steel tie bars over each bearing. Keyways in frame seat each tie bar and lock it in place, permanently preserving alignment.

AVAILABLE SIZES AND TYPES range from 300 to 10,000-hp with pressures from vacuum to 35,000 psig. A few applications include (figures indicate orders of magnitude only): *dry vacuum pumps* operating at very low pressures, *standard shop air compressors* (125 psig), *refrigeration gas compressors* (250 psig), and *multi-stage gas compressors* for use in service such as ammonia synthesis, methanol and hydrogenation plants (3500 to 35,000 psig). For more information, write for Bulletin L-679-B1 on company letterhead. Worthington Corporation, Section K.5.2, Harrison, New Jersey.

Opposed Compressor Design and MAINTENANCE COSTS





COMPRESSED AIR for Ford plant in Mahwah, New Jersey, is supplied by this array of four 450-hp, 100 psig Worthington Balanced Opposed Compressors.

HIGH-SPEED, LOW INERTIA Worthington Feather® Valve contributes to quiet operation and easy maintenance of Worthington Balanced Opposed Compressor. Thin, flexible strips of stainless ribbon steel form active elements. Curved guards hold strips in position over rectangular openings. Strips lift and flex uniformly against guards. Absence of impact results in quiet operation, longest valve life and low maintenance costs.

WORTHINGTON

K-5-2

Only Worthington Compressors give you Feather Valve Performance

Y-Types • Balanced Angle • Horizontal • Portable • Radial • Gas Engine Compressors

For more data on advertised products, use Readers' Service Cards, last page.

PRE-TESTED!

CHASE® ANTIMONIAL ADMIRALTY HEAT EXCHANGER TUBES

are made to last years longer!

All the hydrostatic tests, corrosion tests, expansion and flattening tests which go on at the Chase mills are designed for one thing—to assure *years* of extra service from Chase Antimonial Admiralty Heat Exchanger Tubes.

But the real test takes place right on the job—where stresses, strains and corrosion are at their very worst. Chase Antimonial Admiralty Heat Exchanger Tubes pass *that* rugged trial with flying colors!

It follows that the longer heat exchanger tube life you get from Chase Antimonial Admiralty *also* means lower operating costs, fewer breakdowns and more time between tube replacements!

Get the benefit of extra years of service—insist on Chase Antimonial Admiralty!

Chase®

BRASS & COPPER CO.

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

CHASE WAREHOUSE STOCKS: Houston,* Los Angeles, New Orleans, Tulsa**

*Handled by Standard Brass & Mfg. Co. **Handled by Vinson Supply Co.

The Nation's Headquarters for Brass & Copper

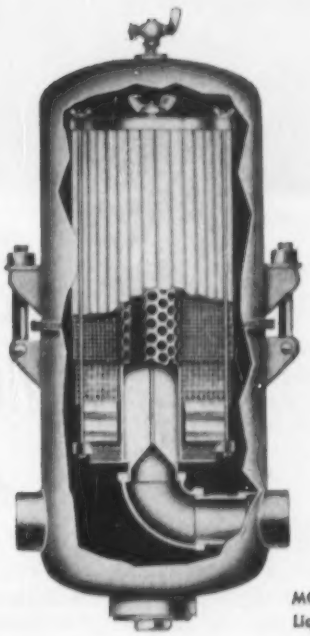
Albany†	Chicago	Detroit	Los Angeles	New York	St. Louis
Atlanta	Cincinnati	Grand Rapids†	Milwaukee	Philadelphia	San Francisco
Baltimore	Cleveland	Houston	Minneapolis	Pittsburgh	Seattle
Boston	Dallas	Indianapolis	Newark	Providence	Waterbury
Charlotte†	Denver	Kansas City, Mo.	New Orleans	Rochester†	(†sales office only)

For more data on advertised products, use Readers' Service Cards, last page.

STAYNEW LIQUID FILTERS

PROVIDE DEPENDABLE DAY IN DAY OUT PERFORMANCE

PRACTICALLY any liquid can be efficiently and economically filtered by a Staynew Liquid Filter. They are designed for adaptation to virtually any space requirement or any arrangement of inlet and outlet connections. All known types of filtering media are available to provide any degree of efficiency for any specific problem, or for use regardless of temperature, pressure or corrosion requirement. All units can be constructed according to the API-ASME and the various ASME Code specifications. Staynew Model ELS liquid filters are available in many types of materials other than regular steel, such as stainless steel, monel, herculoy and other non-corrosive materials.



MODEL ELS
Liquid Filter

PARTIAL LIST OF LIQUIDS THAT CAN BE FILTERED BY STAYNEW LIQUID FILTERS

Acetone
Acids
Adhesives
Alcohols
Alkalis
Ammonia
Asphalt
Benzene
Benzine
Beverages
Butane
Casein
Castor Oil
Caustic
Cellulose Solutions
Chlorine
Chocolate
Cleaning Fluids
Coating
Coolants
Cutting Oils
Emulsions
Enamels
Ethanolamine
Ethylamine
Extracts
Flameproofing Solutions
Fuel Oil
Furniture Polish
Gasoline
Glue
Greases
Gums
Hydraulic Fluids
Ink
Kerosene
Lacquers
Latex
Liquid Paraffin
Lubricants
Molasses
Naphtha
Paint
Pharmaceuticals
Propylene
Quenching Oils
Resins
Rubber Cements
Sizing
Soap
Solvents
Steam Condensate
Syrups
Tar
Turpentine
Varnish
Vegetable Oils
Viscose
Water
Wax

SEND for this 12-page bulletin D-IL containing specifications, engineering and performance data, photos and descriptions of recommended types of filter media, check list of liquids that can be filtered and other helpful data.

DOLLINGER PROTECTED STAYNEW FILTERS

Representatives in Principal Cities

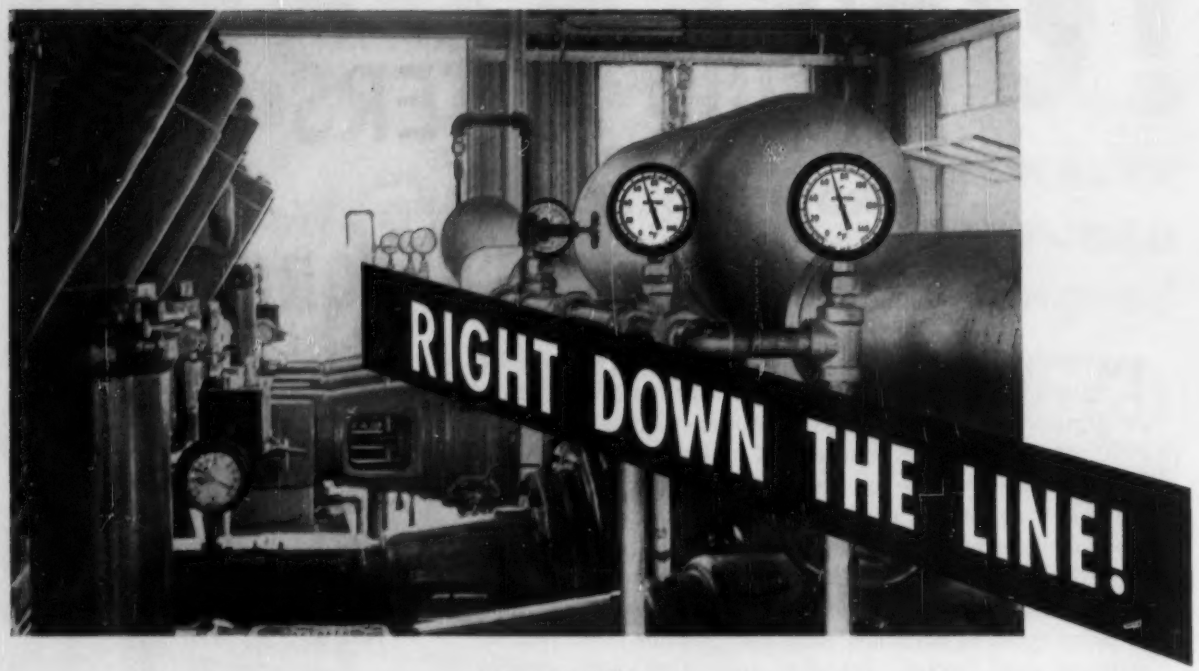
DOLLINGER CORPORATION

47 Centre Pk., Rochester 3, N. Y.

ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED

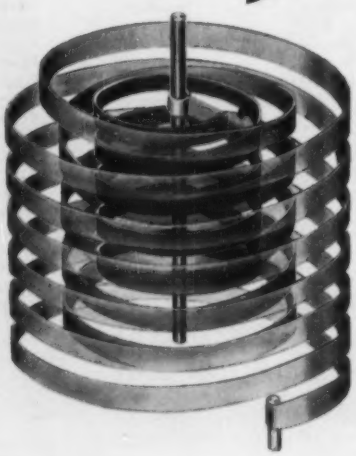
For more data on advertised products, use Readers' Service Cards, last page.

DEPENDABILITY



Weston thermometers with Multiple bimetal helix

The reasons why WESTON all-metal industrial thermometers excel in dependability and long life . . . enjoy such outstanding preference throughout industry . . . stem in large part from Weston's exclusive design and manufacturing methods. The critical *sensing elements* are all Weston-made in the shorter *multiple helix* form to insure rugged, *nonsagging* units. They are then *cycle-seasoned*, over broad temperature ranges, to insure *consistently precise indications* over far longer periods. Thus they serve better, longer, at far lower over-all costs. Bulletin containing sizes, ranges and prices, available on request. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Ave., Newark 5, N. J.



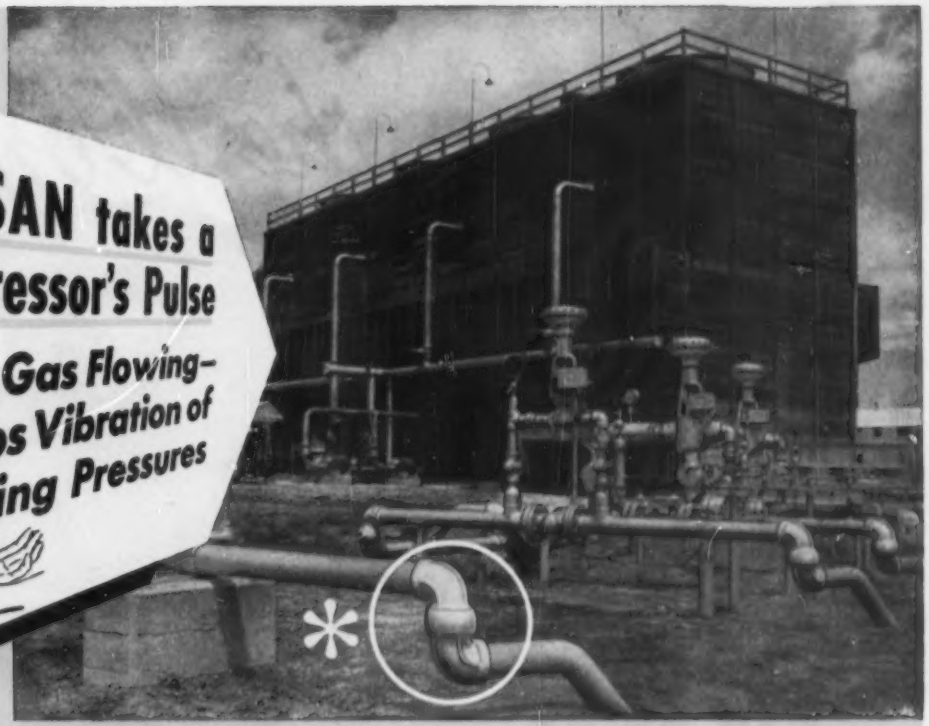
WESTON

Thermometers

AVAILABLE THROUGH LEADING DISTRIBUTORS

CHIKSAN takes a Compressor's Pulse

Keeps Gas Flowing—Absorbs Vibration of Changing Pressures



Not only do the stamina and flexibility of Chiksan Joints take expansion in their stride, they absorb pulsation and vibration.

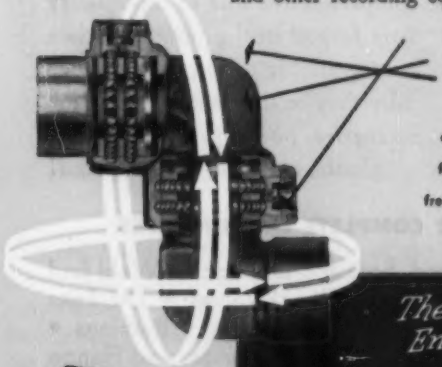
When the Plymouth Oil Company wanted a better way to handle the expansion and contraction of its 2500-3500 lb. natural gas re-pressuring line in its compressor station in Sinton, Texas, back in 1946, it tried Chiksan 2-inch high pressure ball bearing swivel joints. So successful were Chiksan Joints in this application, they were adopted for 3 and 4-inch lines for the same purpose. In addition, by placing regulators, gauges and other recording equipment on a bridge using Chiksan Joints, accurate readings of the instruments could be obtained.

Since 1946, not one of these Chiksan Joints has been replaced or even repacked, and they are giving the same economical, dependable service they did when first installed.

In Texas or California — all over America and all around the world — wherever production, processing or distribution depends on the flow of liquid or gas or on the dependability of hydraulic systems, there you will find Chiksan Ball Bearing Swivel Joints on the job — adding muscle and flexibility — cutting down on shut-downs and maintenance.

Whatever your business, if gas or liquid plays a part, Chiksan's Research and Development Division can help you add efficiency, safety and economy to your operation.

Representatives in Principal Cities
Write for Catalog 53-C, Dept. PR-7



CHIKSAN Ball Bearing Swivel Joints are THE NEW TOOL of Modern Industry — with full 360° rotation in 1, 2, and 3 planes. Over 1,000 different types, styles and sizes have been developed for pressures and services from 28" vacuum to 15,000 psi and for temperature ranges from minus 75° to a plus 500° F. with packing materials for each specific type of service.

The Flow of Enterprise Relies on **CHIKSAN** *Ball-Bearing Swivel Joints*

CHIKSAN TRADE MARK REG.

CHIKSAN COMPANY • BREA, CALIFORNIA • Chicago 38, Illinois • Newark 2, New Jersey
Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Chiksan Export Company (Subsidiary), Brea, California • Newark 2, N. J.

For more data on advertised products, use Readers' Service Cards, last page.

24 ACRES *Cover the World*

. . . with TOP QUALITY

DROP FORGED STEEL

VALVES, FITTINGS and FLANGES

by

Vogt

Air View of
Henry Vogt Machine Co.

This 24 acre Vogt plant supplies the most comprehensive line of top quality *drop forged* steel piping materials anywhere available to industry. That's why they're the choice of leading refineries, power plants, chemical plants, etc., the world around!

OUR COMPLETE LINE INCLUDES

Flanged, Screwed and Socket Weld End Globe, Gate and Check Valves • Ells, Tees and Crosses • Couplings • Bushings • Plugs • Unions • Flanges and Flange Unions • Welding Heads

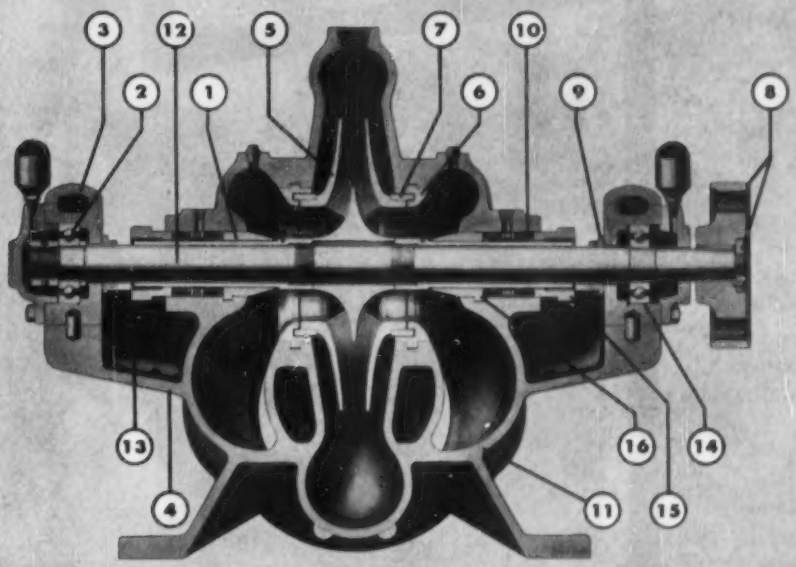
HENRY VOGT MACHINE CO. LOUISVILLE 10, KY.

Branch Offices: New York, Philadelphia, Chicago, Cleveland, St. Louis, Dallas, Charleston, W. Va.

DE LAVAL

SINGLE STAGE CENTRIFUGAL PUMPS

for dependable industrial service



Labyrinth wearing rings minimize leakage...maintain high efficiencies

Labyrinth rings used in these De Laval pumps retard flow of water through labyrinth passage.

Flat rings showing relatively unimpeded flow of water.

① **Shaft Sleeves** are screwed on, to abut the impeller and make a water-tight joint. Sleeve expands freely and independently of shaft when temperatures change. There is no tendency to buckle.

② **Thrust Bearing** locates rotor axially.

③ **Bearing Caps** easily removable for maintenance.

④ **Bearing Brackets** scraped to lining bars for perfect alignment.

⑤ **Impeller** hydraulically balanced, finished on all surfaces.

⑥ **Labyrinth Wearing Rings** held accurately in machined grooves in both case and cover.

⑦ **Impeller Wearing Rings** threaded on impeller, opposite to rotation.

⑧ **Flexible Coupling** ground on all exposed surfaces and statically balanced, complete coupling supplied, pump half mounted on taper so that it can be easily removed. Check nut locks coupling on taper.

⑨ **Deflector** keeps water out of bearing.

⑩ **Stuffing Boxes** extra deep; lantern rings for water sealing.

⑪ **Pump Case** horizontally split; machined to limit gages.

⑫ **Steel Shaft** ground to limit gages.

⑬ **Drip Boxes** large; provided with drain openings.

⑭ **Radial Bearing** free to move axially, thus avoiding temperature strains.

⑮ **Glands** split horizontally.

⑯ **Protecting Bushings** renewable.

You can count on the performance of the De Laval Single Stage Centrifugal Pumps because they are precision-made to high manufacturing standards and incorporate the many quality design features shown in the cross-section.

They operate at high or low speeds, at high or low heads...with maximum efficiency.

For example, De Laval G, I and K Single Stage Double Suction Pumps have a capacity range of 175 gpm to 6,000 gpm, and heads to 300 feet. They are available in sizes ranging from 4" suction and 3" discharge to 14" suction and 12" discharge. Write for Bulletin 1002.

DeLaval also furnishes larger centrifugals for capacities up to 70,000 gpm.

DE LAVAL *Centrifugal Pumps*

DE LAVAL STEAM TURBINE COMPANY
811 Nottingham Way, Trenton 2, New Jersey

DL 104

DUAL METAL ... answer to

What is it ?

To thirty-one of America's largest industries with problems of abrasion or corrosion—or both—"Dual Metal" means U. S. Pipe's Special Products Division.

Specifically, "Dual Metal" is our name for centrifugally cast cylindrical sections in which two dissimilar metals are bonded metallurgically by centrifugal force and temperature.

"Dual Metal" centrifugally cast, integrally fused combinations of two dissimilar metals are doing industry's most difficult and exacting jobs better and more economically than ever before.

Design engineers have been quick to recognize the outstanding merits of a process capable of combining the desired mechanical and chemical properties no single metal possesses.

"Dual Metal" means versatility, efficiency and economy.

Research and development play a vital and important role in the centrifugal casting of "Dual Metal" combinations. Our Pilot Foundry is devoted entirely to process and product improvement.

UNITED STATES PIPE & FOUNDRY CO.

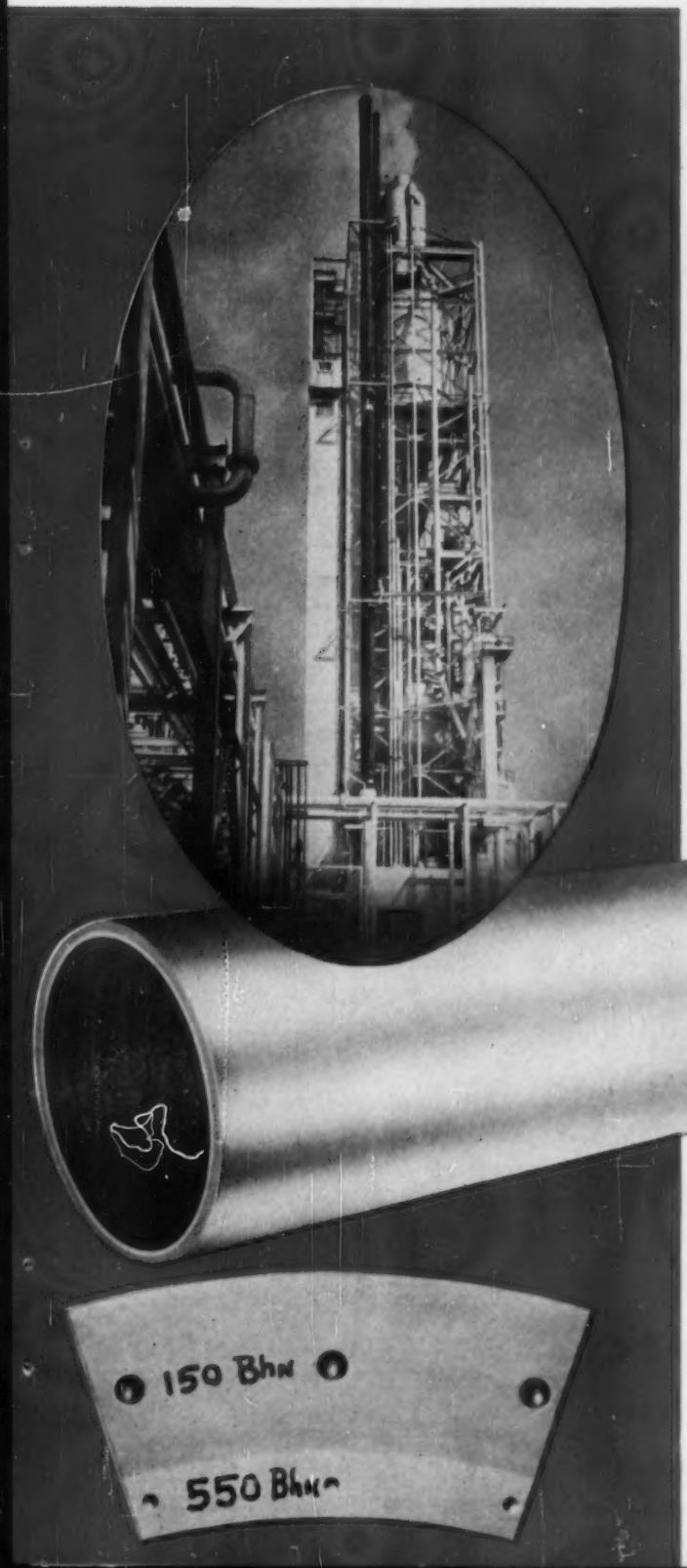
Special Products Division

SPECIAL PRODUCTS DIVISION U S P

BURLINGTON, NEW JERSEY

SALES OFFICES: LOS ANGELES, SAN FRANCISCO, CHICAGO, ST. LOUIS, CLEVELAND, DETROIT, PITTSBURGH, HARTFORD, BURLINGTON

your TURNAROUND problems



"Dual Metal" solves one of the petroleum industry's most severe and costly problems—catalyst erosion of lift pipe and catalyst handling lines.

In making a "Dual Metal" lift pipe the outer shell of weldable alloy steel is poured into a rapidly rotating mold. The abrasion-resistant alloy iron core is introduced at the proper time and temperature. Result? A metallurgically bonded two-metal structure that combines the strength and weldability of low alloy steel and the superior abrasion resistance of alloy iron.

"Dual Metal" lift pipes are now in use in over 60 of the nation's leading refineries. In one typical refinery periodic examinations of high temperature catalyst pipes have indicated abrasion resistance of better than 16 to 1 over conventional steel piping. A once-troublesome bottleneck in processing has been eliminated and turnaround operations made shorter—a major saving of both time and money.

Perhaps this versatile process is the answer to your particular problem. Write today for specific literature and information on "Dual Metal's" applications for the refining industry.

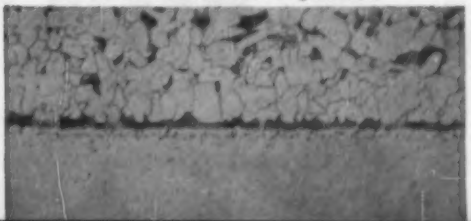
"DUAL METAL" CENTRIFUGAL CASTINGS: SIZE RANGES

OUTSIDE DIAMETER: 6" to 36" WALL THICKNESS: ½" and up
LENGTH: Up to 14 ft. without welding
TYPICAL OIL INDUSTRY APPLICATIONS: Catalyst Lift Pipe, Depressurizing Pipe, Catalyst Transfer Lines, Slush Pump Liners, Valve Nozzles, Extrusion Liners, etc.

Left. *Cross-section view of dual metal piping consisting of a weldable SAE 4120 steel outer shell and a metallurgically bonded inner layer of high carbon-high chromium abrasion resisting iron. Photograph actual size. Composition of the hard inner layer:*

C	Mn	P	S	Si	Cr
2.85	1.10	.009	.023	.85	29.36

Below. *Photomicrograph showing the bond or fusion zone between the outer and inner metals. The mild etch required for the 4120 steel did not attack the high chromium iron. Etched—100 diameters magnification.*



HERE'S WHAT TO LOOK FOR IN REFRACTORY CASTABLES... and WALSH has them all...

(thanks to better research and ceramic engineering)

Walsh Lite-Wate Castable No. 50 demonstrates remarkable trowelling workability

- **Uniform grain sizing assuring homogeneous structure for greater strength... better bond . . . throughout complete temperature range.**
- **Maximum resistance to abrasion.**
- **Ease of installation—whether by casting, trowelling or air gun placement.**
- **Highest modulus of rupture without sacrificing low "K" factor . . . wanted feature in light weight castables.**

These and many other advantages add up to performance characteristics that make Walsh Castables an investment in greater production... lower cost.

THEY'RE HOMOGENIZED

Lite-Wate Castable No. 50 . . . weight, dry, in place, 50 lbs. per cu. ft.

Lite-Wate Castable No. 70 . . . weight, dry, in place, 70 lbs. per cu. ft.

H & B Castable . . . weight, dry, in place, 130 lbs. per cu. ft.

Super Castable No. 32 . . . weight, dry, in place, 125-130 lbs. per cu. ft.

There's a light weight insulating or high temperature service type to meet your exact need. Get the whole time, labor and money-saving story from your nearest Walsh distributor or write us direct for complete data, temperature limits and prices.

WALSH REFRACTORIES CORPORATION — America's Best Clays

WALSH REFRACTORIES CORPORATION

101 FERRY STREET • ST. LOUIS 7, MISSOURI

FOR OVER 60 YEARS MANUFACTURERS OF HIGH GRADE REFRACTORIES

Specified for More Jobs than any other small forged steel gate valve

CHAPMAN List 960

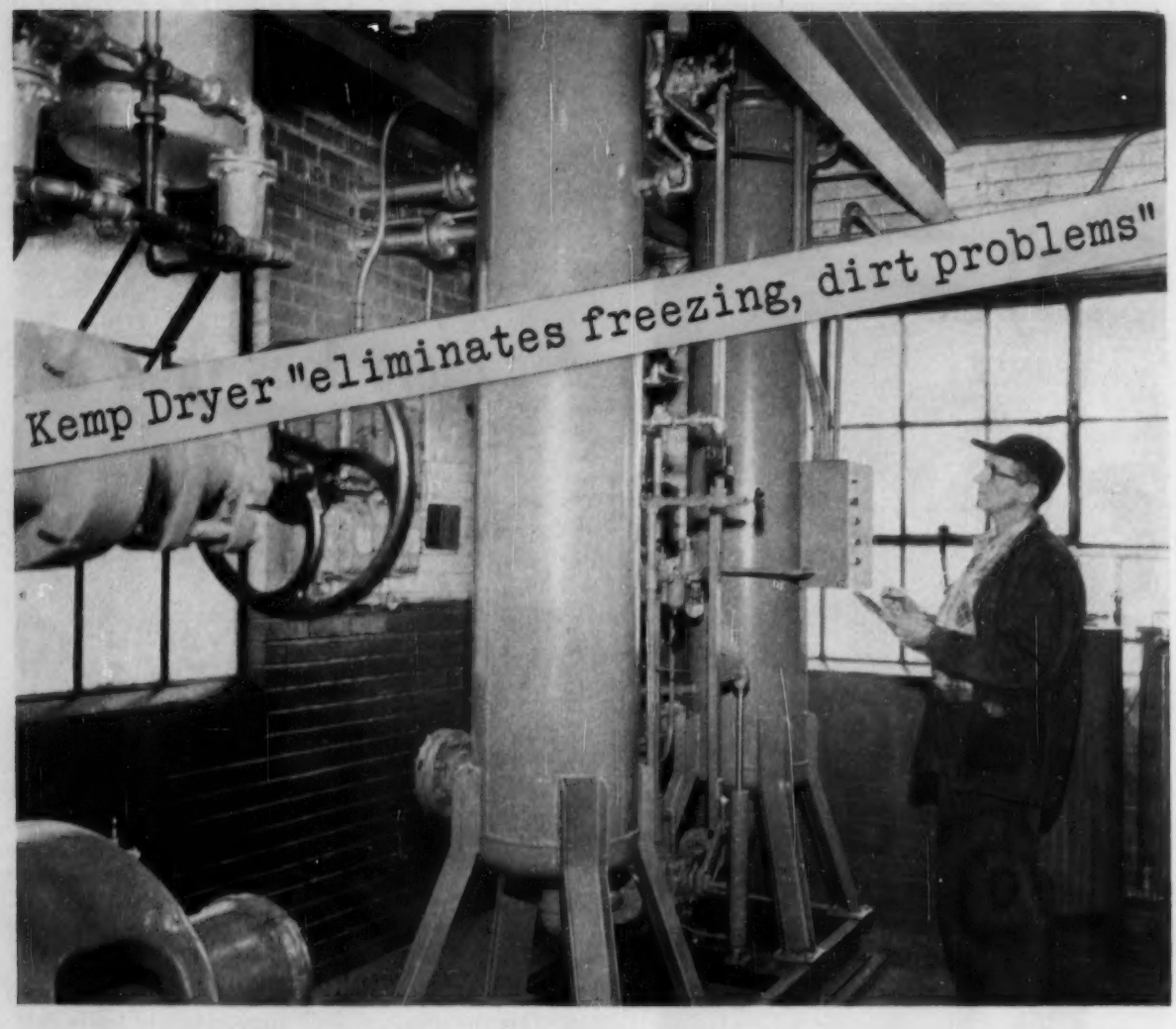
Chapman List 960 is specified for more different applications than any other small forged steel gate valve in the world. Engineers know that List 960 valves keep maintenance expenses low under the most severe service conditions.

Seizing and galling are virtually eliminated, because wedge gate faces are superhardened to 800 Brinell. Stainless steel seat rings, hardened to minimize wear, are easy to replace, make it unnecessary to lap-in gate and seats. Stem guide passages are carefully machined to minimize stresses, keep operation smooth and trouble-free over long periods. Stem-and-gate connection is extra strong where extreme stresses can develop.

For every application you have for small forged steel gate valves, specify Chapman List 960. Sizes from ¼″ to 2″. Rising stem with yoke (shown) or rising stem with inside screw. Metal-to-metal or gasketed bonnet joint, depending on application. Pressure range to 2000 pounds at 100°F, to 380 pounds at 1000°F. For higher pressures, specify List 990. Write for your copy of Catalog 10 now.

The Chapman Valve Manufacturing Co.
INDIAN ORCHARD, MASSACHUSETTS

For more data on advertised products, use Readers' Service Cards, last page.



Quaker State Reports: *Kemp Dryer protects instrument lines from freezing at temperatures of 25° below zero*

Instrument failure is now a rare thing at the Quaker State Refining Corp., Farmers Valley, Pa. Quaker State installed a Kemp 300-E Oriad Dryer in December, 1954, and according to Process Supervisor Joe Brown it has really done a job safeguarding instrument operation.

Kemp Saves Time, Labor

The company no longer has to steam trace or insulate instrument air lines. A longer period of time can be allowed between servicing instruments. Even at temperatures of 25° below zero, none of the lines froze. And to further save time and manpower, the dryer is fully automatic! Between its "elimination of instrument failure and ease of operation," Kemp earned its place on the Quaker State team.

Kemp Dryers for Every Purpose

Kemp offers a variety of dryer models to meet all problems. Designed to dry air, gases or liquids to sub-zero dew points at low cost, they are constructed of quality materials and embody the engineering knowledge gained from Kemp's many years of experience. They are available with manual, semi-automatic, or fully automatic tower reactivation. In addition, Kemp will prescribe the proper desiccant for each specific drying job. If you have a problem involving the removal of water from air, gases, or liquids, contact Kemp engineers now. For complete facts and technical information, write for Bulletin D-27.

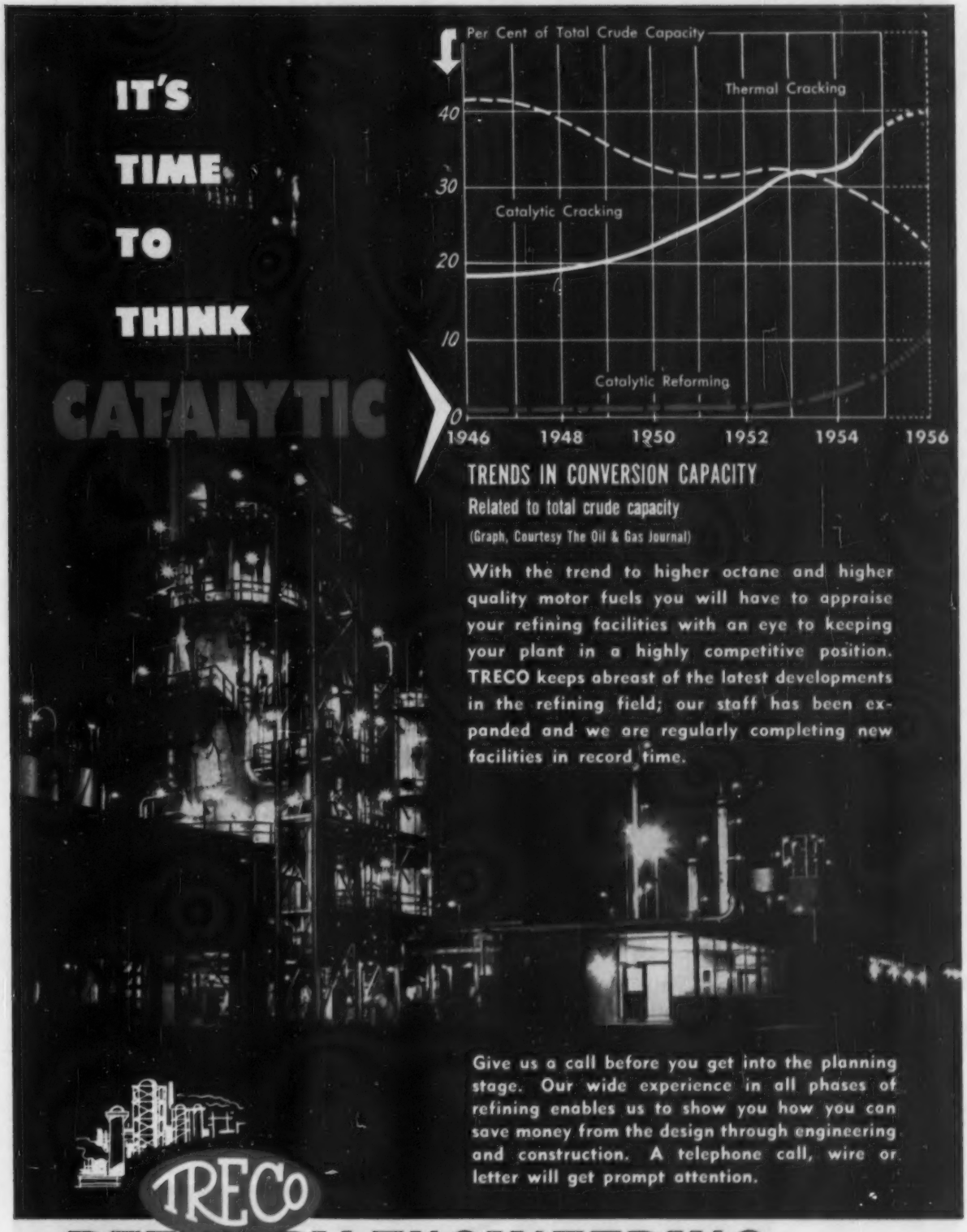
KEMP OF BALTIMORE

DYNAMIC DRYERS

CARBURETORS • BURNERS • FIRE CHECKS
METAL MELTING UNITS • INERT GAS GENERATORS
SINGEING EQUIPMENT

THE C. M. KEMP MFG. CO.
405 East Oliver Street, Baltimore 2, Maryland

IT'S TIME TO THINK CATALYTIC



TRENDS IN CONVERSION CAPACITY

Related to total crude capacity

(Graph, Courtesy The Oil & Gas Journal)

With the trend to higher octane and higher quality motor fuels you will have to appraise your refining facilities with an eye to keeping your plant in a highly competitive position. TRECO keeps abreast of the latest developments in the refining field; our staff has been expanded and we are regularly completing new facilities in record time.

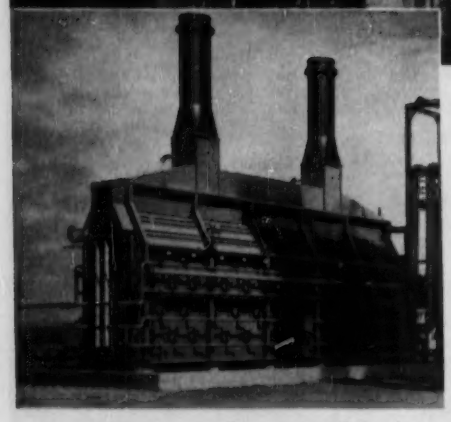
Give us a call before you get into the planning stage. Our wide experience in all phases of refining enables us to show you how you can save money from the design through engineering and construction. A telephone call, wire or letter will get prompt attention.

TRECO

REFINERY ENGINEERING Company

TULSA TORONTO

For more data on advertised products, use Readers' Service Cards, last page.



Multiple Coil Heating Cuts Costs ...is More Efficient..Requires Less Space For Catalytic Reforming

Zone control of Selas Gradiation Heaters permits independent operation of more than one coil in a single radiant setting. Sun Oil Company takes advantage of this feature in the 3-coil Houdriforming unit at its Sarnia, Ontario, plant in the making of high octane gasoline. Installations of this type can provide:

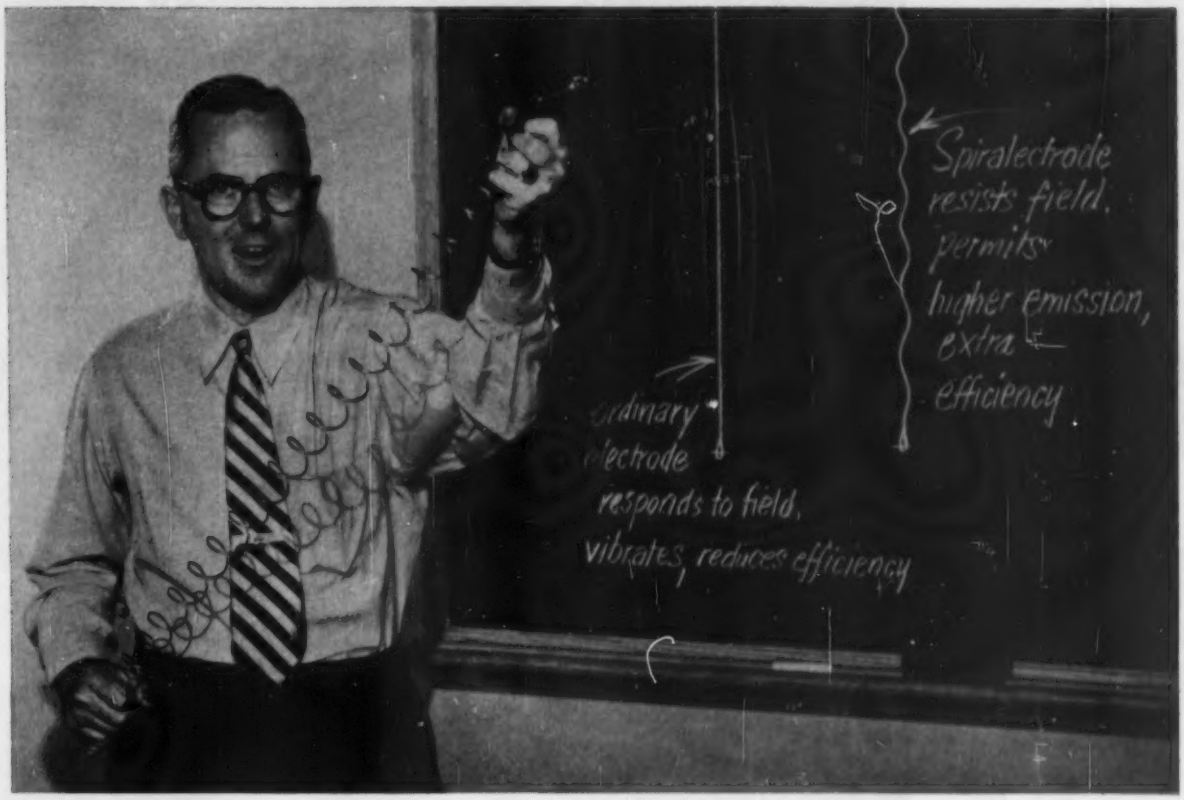
Compact heating units with multiple coils and absolute temperature control in a single radiant chamber . . . Flexibility in shaping the heating curve . . . Complete combustion with little or no excess air . . . Prolonged tube life—lower maximum tube wall temperature, through more uniform circumferential heat distribution . . . Rapid response, with ± 1° F. temperature control.

Selas Gradiation Heaters are currently in operation in most of the major catalytic reforming processes. Where two or more process streams require separate heating you'll find it worthwhile to investigate Selas Gradiation Zone Control. Write for new bulletin on selection of heaters.

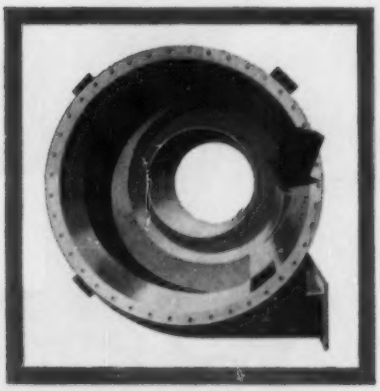
SELAS FLUID PROCESSING

CORPORATION OF AMERICA • PHILADELPHIA 34, PA.

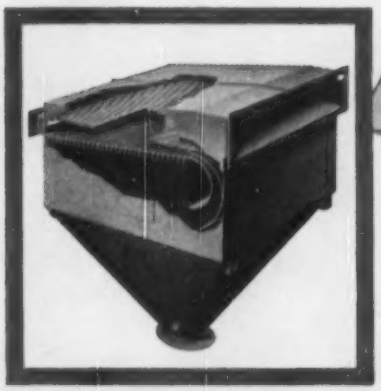
How Buell's Unique Spiralectrodes deliver EXTRA DUST COLLECTION EFFICIENCY!


Spiralectrode resists field, permits higher emission, extra efficiency
Ordinary electrode responds to field, vibrates, reduces efficiency

Coupled with the unique spiralectrode feature is Buell's Continuous Cycle Rapping—the most effective mechanism yet developed for dry dust precipitation. Completely eliminates puffing, keeps electrodes constantly clean. Re-entrained dust is minimized, peak efficiency is maintained.



Buell Cyclones also deliver extra efficiency, due to exclusive shave-off which harnesses double-eddy and puts it to work!



Buell's Low Resistance Fly Ash Collector combines top efficiency with low draft loss, for natural or forced draft installations.

For the complete story behind Buell's *extra efficiency*, write Dept. G-21, Buell Engineering Company, 70 Pine Street, New York 5, N. Y.

buell

MECHANICAL ELECTRICAL *Experts at delivering Extra Efficiency in* **DUST COLLECTION SYSTEMS**

For more data on advertised products, use Readers' Service Cards, last page.

NEW Advanced Design...

- **NEW HIGH SUSTAINED ACCURACY . . .** even under extreme operating and ambient conditions

- **NEW CONVENIENT ZERO ADJUSTMENT . . .** external—no need to remove weather-proof cover

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

d/p Cell Flow Transmitter...

NEW POSITIVE OVERRANGE PROTECTION . . . up to full 1500 lbs. cell rating

6 Major Achievements!

NEW FULLY ADJUSTABLE RANGE . . . from 0-50" to 0-250" H_2O differential

NEW AUTOMATIC INTERNAL DAMPING . . . fast, stable measurement

NEW SIMPLICITY . . . lowest cost installation

Pioneered by Foxboro 7 years ago, the d/p Cell* Transmitter established a new standard of performance in flow measurement and control. Over 40,000 are maintaining that standard in every branch of industry today. Technical advances, based on this unequalled experience, now have added even further reliability, economy and convenience. Call your Foxboro representative for a demonstration. Write for new Bulletin 13-11.

*Reg. U. S. Pat. Off.

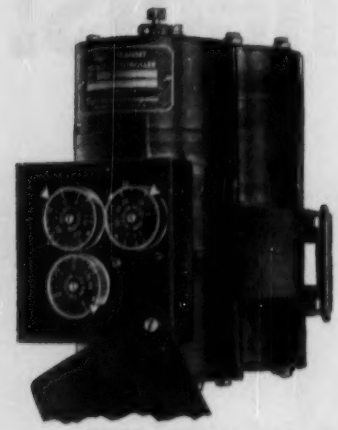
FOXBORO
REG U S PAT OFF

first in flow measurement

THE FOXBORO COMPANY, 747 NEPONSET AVE., FOXBORO, MASS., U.S.A.

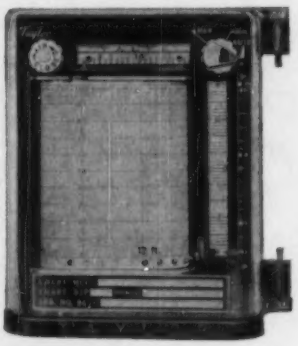
TRANSET* System sets low maintenance records!

BELIEVE IT OR NOT, we've actually heard maintenance men complain because their Transet Instruments never give them a chance to use the maintenance "know how" they had so studiously acquired. For months and, is some cases, even years at a time the instruments require no attention. Here are some reasons for this outstanding dependability:



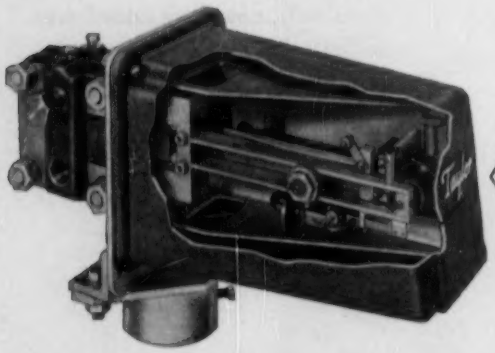
CONTROLLERS

Design and flexibility of neoprene-impregnated diaphragms makes for strength and long life. Can be used on pulsating flows without deteriorating, and are impervious to oil vapors often present in air systems. Simple circuit reduces number of possible trouble points, and force-balance action means minimum of moving parts. Large volume relay valve reduces chances of plugging. Unique nozzle-baffle arrangement is not as susceptible to damage as in other controllers. Built in cut-off relay permits locating instruments behind board or in the field with no change in interchangeability of recorders. Only two adjustments are ever needed for maintenance—and plug-in feature means minimum time off automatic control.



RECEIVERS

Ruggedly housed bellows in receiver units protects it from external damage. Continuous bleed from the reducing valve keeps it purged—free from dust and dirt. Many have been in service over four years without requiring calibration to zero. Units are easy to get at for service, no matter how close on the board, because they can be unplugged. Plug-in feature also means that indicators can be replaced by recorders for analyzing trouble. Removable chart drive is another aid to establishing process problems.



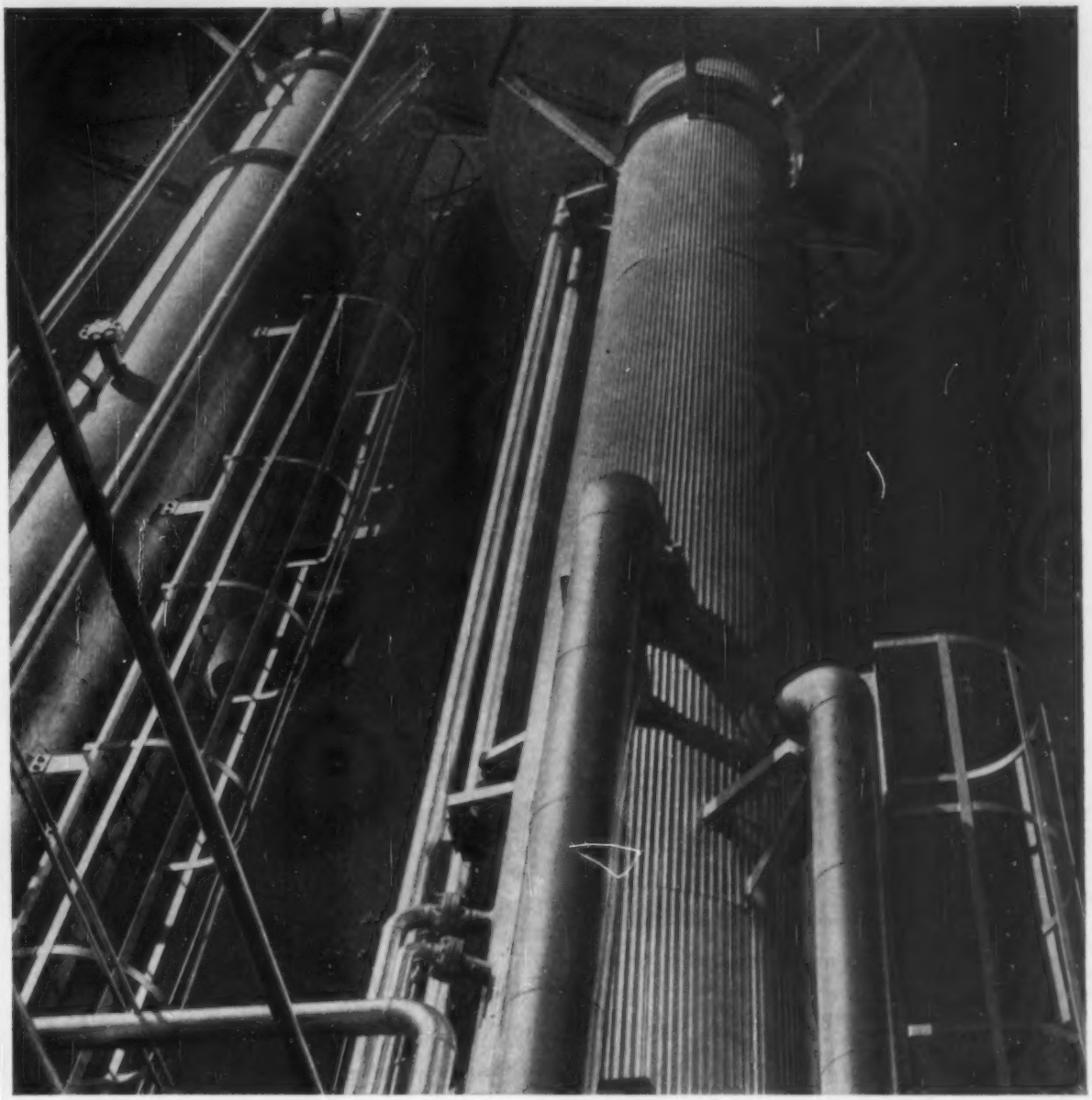
TRANSMITTERS

Both temperature and flow transmitters are ruggedly housed. Located at the point of measurement, they are out of the way of possible damage. Quick, simple range-change features mean minimum maintenance time for changes in product or seasonal demand. Force-balance construction—no seal pots. Follows flows quickly because of low volumetric displacement. Self draining and venting.

For full details about the TRANSET system call your Taylor Field Engineer, or write for **Bulletin 98097.** Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

*Reg. U.S. Pat. Off.

Taylor Instruments MEAN ACCURACY FIRST



Unibestos® keeps 1175° where it belongs

Catalytic cracker...vacuum still and "poly" plant—all get added protection against heat loss with strong, single-layer Unibestos Pipe Insulation.

And Unibestos starts cutting costs right at the beginning. Unibestos, made of African Amosite, is easy to handle, easy to cut and miter. Long, interlacing fibers assure positive heat seals between sections...reduce pointing of joints...simplify insulation of fittings.

Built to resist thermal shock, vibration, and unaffected by most acid and chemical fumes, Unibestos can be easily removed and effectively reapplied when lines are relocated or replaced.

Standard Production Sizes

Unibestos Pipe Insulation is regularly made in 3-foot lengths for pipe sizes from ½″ through 24″, in standard thicknesses through 5″. Unibestos Block Insulation is made in 6″, 12″, 18″ or 36″ widths and in thicknesses from 1″ through 3″ in ½″ increments.

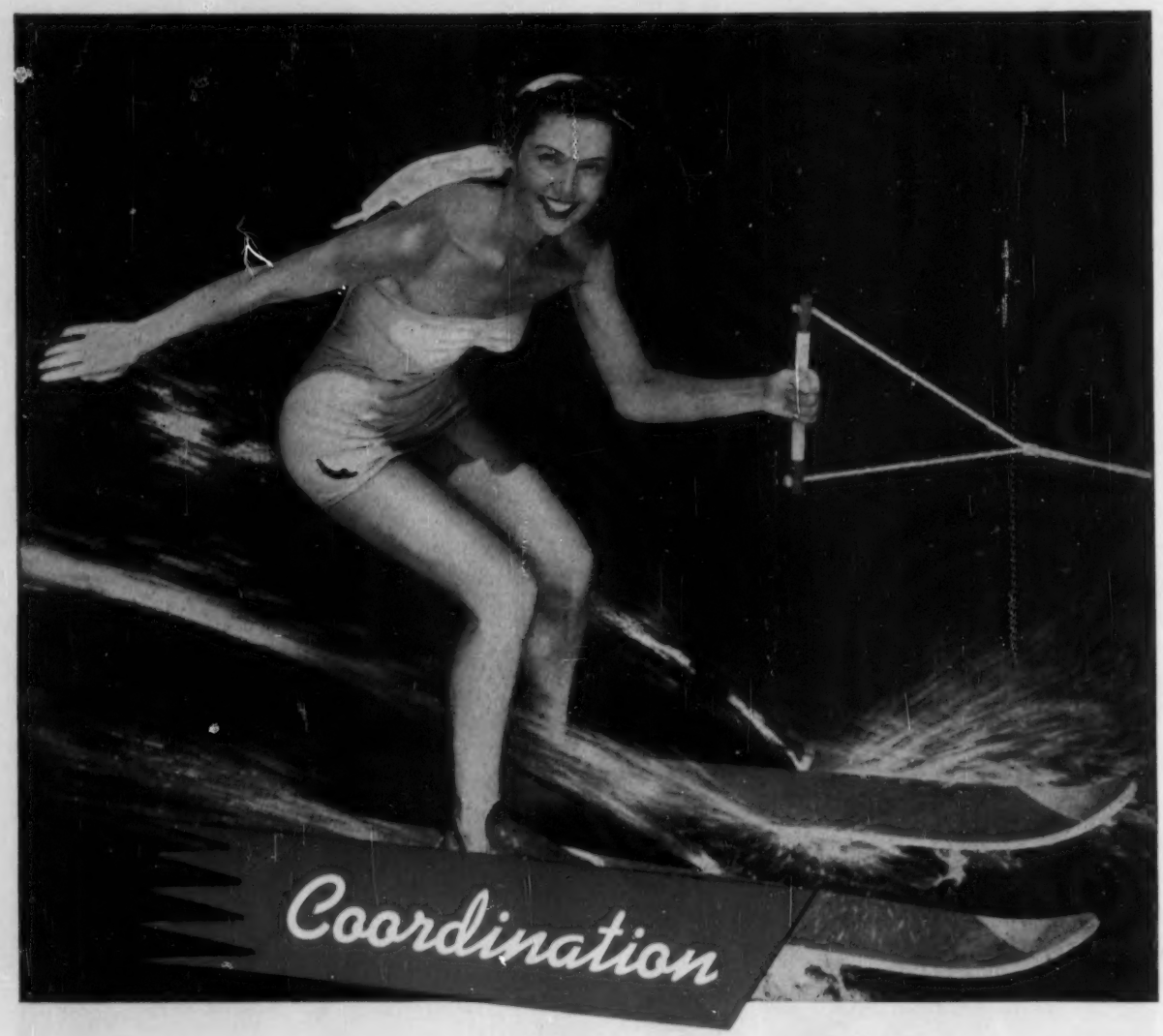
For complete information, write for descriptive Bulletin 109C

UNARCO

UNION ASBESTOS & RUBBER COMPANY

1111 West Perry Street • Bloomington, Illinois

For more data on advertised products, use Readers' Service Cards, last page.



Your next job of high-temperature or high-pressure piping merits the coordinated skills of Mitchell. You can give us the whole problem from start to finish, or participate—with our full cooperation, as you please. For assured satisfaction and economy, send us your drawings for estimate.

W. K. MITCHELL & CO., INC.
Philadelphia 46, Pa.

WESTPORT JOINT
(PATENTED)

MITCHELL PIPING
SINCE 1899

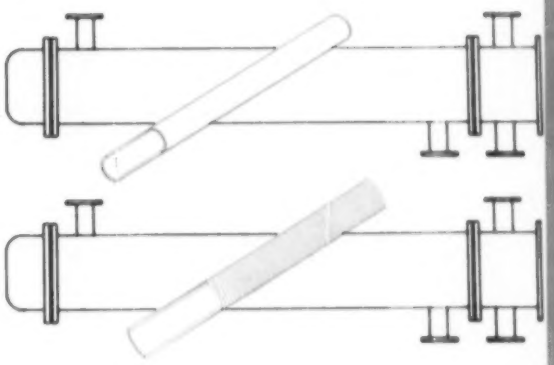
PIPING FABRICATORS AND CONTRACTORS

An opportunity to cut oil cooler costs—Number 7 of a Series

HOW

[redacted]

BOOSTED BTU/HR OUTPUT OF OIL COOLERS



When [redacted] of [redacted] shifted from Prime surface condenser tubing to Wolverine Trufin* Type S/T condenser tubing for their oil cooler installations two startling facts showed up right away.

BTU/HR OUTPUT SOARED—

COSTS PLUMMETED!

Reasons were amazingly simple. Trufin, because it is a finned tube, provided up to twice as much outside surface area for heat transfer. And, because the fins and the tube wall were all one piece—integral—they stood up under the stress and strains of vibration, pressures and temperature changes. This meant more on-stream time—dependable performance for [redacted] Trufin's heat transfer performance was much higher than plain tubing. Results—more BTU's/Hr in the same unit at reduced costs.

*REG. U.S. PAT. OFF.

Here are the facts:

	Trufin Condenser Tubing	Plain Condenser Tubing
Tube Specifications	¾" Admir. Trufin Condenser Tubing	¾" Admir. Plain Condenser Tubing
Length of Tube Bundle	48 inches	48 inches
Shell Diameter	8 inches	8 inches
No. of Tubes in Bundle	50	50
Total Outside Surface Area	79 sq. ft.	38 sq. ft.
Shell Side Fluid	Oil	Oil
Tube Side Fluid	Water	Water
Shell Side Flow Rate	39,200 lb./hr.	37,430 lb./hr.
Heat Transfer Duty	284,000 BTU/HR.	192,000 BTU/HR.

Trufin saves dollars on the new installations at [redacted] because smaller heat exchangers can be designed—that means less tube, smaller shells and headers.

Selection can be made from a wide range of sizes in copper, copper-base alloys, aluminum and electric-welded steel. Write for a copy of the Wolverine Opportunity Book. It's 'proof positive that Trufin will do a job for you! Wolverine Tube, 1437 Central Avenue, Detroit 9, Mich.

Investigate Today —and Save!

Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ontario

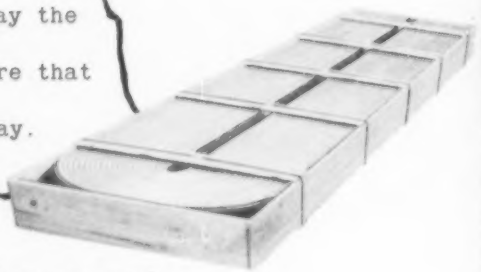
WOLVERINE TUBE
DIVISION OF CALUMET & HECLA, INC.
Manufacturers of Quality Controlled Tubing and Extruded Aluminum Shapes

WHAT

~~The Warwick Petroleum Corporation~~

had to say about Wolverine U-Bend Pallets for Condenser Tubes

. . . Our shop was very pleased with the way the U-bends were packed and expresses the desire that all future shipments be handled the same way.



We asked for *more* information—and this is what we got!

From the Chief Engineer . . .

Q. Mr. ~~Hammond~~, in your opinion, what is the big advantage of Wolverine U-bend palletized condenser tubes?

A. The fact that condenser tubes are shipped to us in an orderly fashion. We used to have dozens of different bends in stock and when we had to retube we had to spread the various tubes out on the floor in front of the condenser. In other words, we needed a lot of space and had to do a great deal of time-consuming handling.

Q. And how did the U-bend pallet help?

A. Now, we just set the pallet in front of the condenser and remove the tubes as needed. They are arranged on the disposable box-type pallet in the exact order we need them—right to the prints we supplied Wolverine's Field Engineering Service. We save time, space and money. Another thing, our inventory situation is eased. We just stock complete tube installations and use them as needed.

Q. What other factor did you find helpful?

A. Wolverine provides a direct mill source of supply for all our U-bends, fin condenser tubes and plain condenser tubes. All our requirements can be handled directly with Wolverine.

Q. Were there any other indications of savings?

A. Yes. The U-bends decreased unit costs by eliminating one tube sheet and at the same time cut our rolling-in operations in half.

Q. How about performance?

A. We found that the individual tube bends took care of differential expansion and eliminated floating head problems.

These extraordinary conveniences of Wolverine U-bend palletized condenser tubes can be yours too. Wolverine supplies both prime surface and finned tube *palletized* in a wide range of alloys and sizes in copper, aluminum and electric-welded steel. Look into this opportunity to save! Write for Wolverine's Condenser Tube Book. WOLVERINE TUBE, 1437 Central Avenue, Detroit 9, Michigan.

EST 1916

WOLVERINE TUBE

DIVISION OF CALUMET & HECLA, INC.

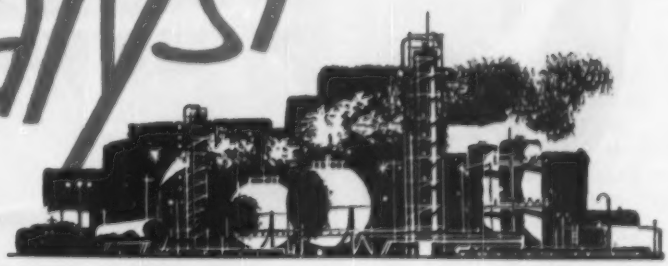
Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.

EXPORT DEPT., 13 E. 40TH ST., NEW YORK 16, N. Y.

Davison M-S®

HIGH ALUMINA Catalyst



DAVISON GIVES YOU HIGH ALUMINA CATALYST IN THE PARTICLE SIZE BEST SUITED FOR YOUR UNIT!

HIGH ALUMINA M-S CATALYST PARTICLE SIZE DISTRIBUTION

The catalyst with a *minimum of fines* . . .

Grade	F-3-25 Extra Fine	F-2-25 Fine	F-1-25 Inter-mediate	C-1-25 Coarse	C-2-25 Extra Coarse
Size range by C.A.E.: Wt. %					
0-10 Microns	4	2	1	1	1
0-20 Microns	9	4	2	2	2
0-30 Microns	16	11	6	5	4
0-40 Microns	28	21	12	10	8
. . . and a *minimum of coarse particles*					
Sieve analysis: Wt. %					
on 100 mesh (149 microns)	0	0	1	1	1
on 140 mesh (104 microns)	1	1	4	6	8
on 200 mesh (74 microns)	4	5	15	22	33

Now Davison has taken the characteristics of High Alumina Catalyst and combined them with the proven advantages of its 13% Alumina Catalyst. This gives you, for the first time, High (25%) Alumina Catalyst with *all* these qualities:

- ***Lower Stack Losses***
- ***Better Maintenance of Activity and Surface Area***
- ***Narrow Particle Size Distribution***
- ***High Attrition Resistance***
- ***High Purity and Uniformity***

For information on Davison High Alumina Catalyst see your Davison Representative or write.

Progress Through Chemistry

DAVISON CHEMICAL COMPANY

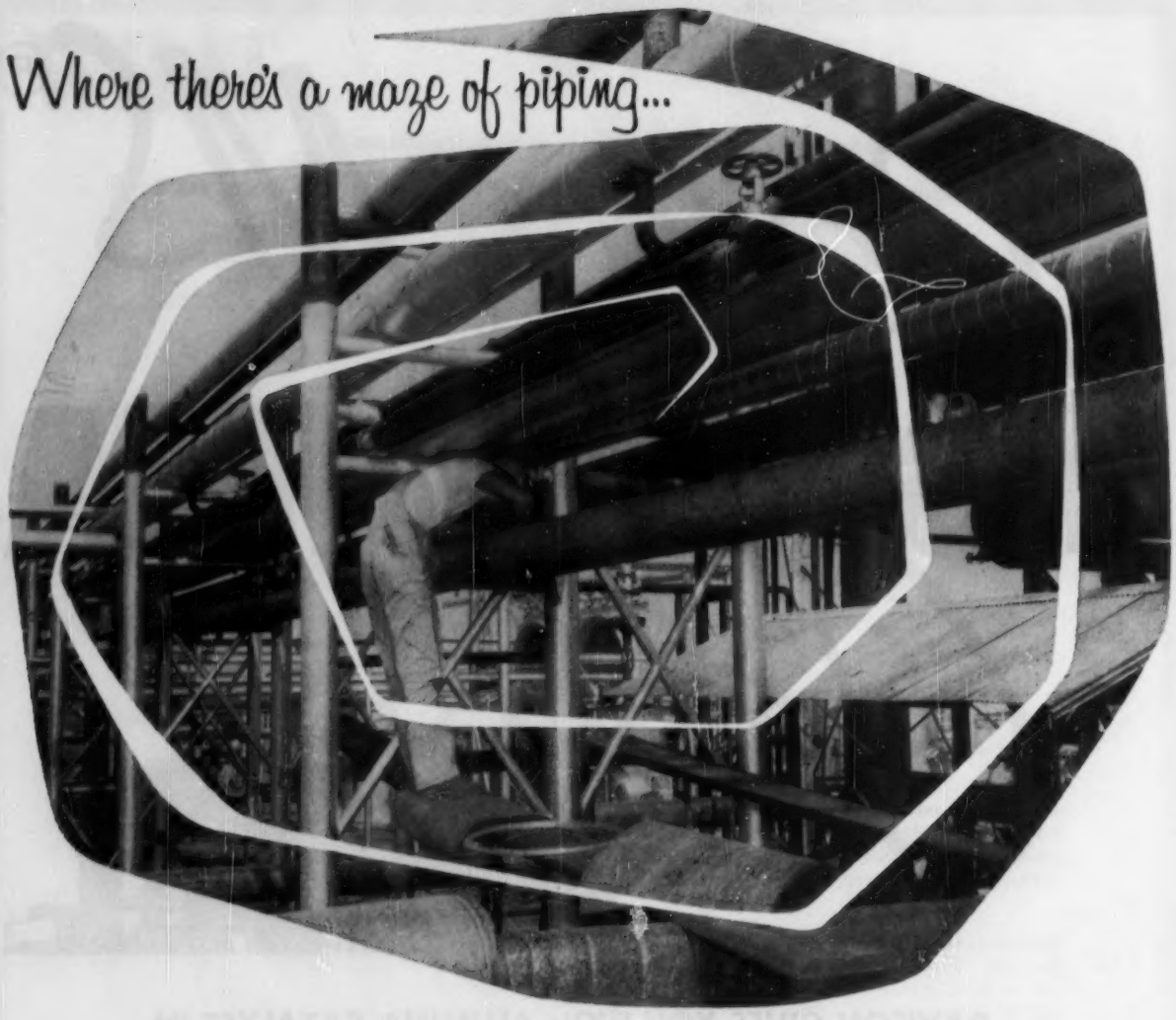
Divison of W. R. Grace & Co.

Baltimore 3, Maryland

Sales Offices: Chicago, Ill.; Houston, Tex.; New York, N. Y.; Baltimore, Md.

PRODUCERS OF: CATALYSTS, INORGANIC ACIDS, SUPERPHOSPHATES, TRIPLE SUPERPHOSPHATES, PHOSPHATE ROCK, SILICA GELS AND SILICOFLUORIDES. SOLE PRODUCERS OF DAVCO® GRANULATED FERTILIZERS.

Where there's a maze of piping...



...there's an amazing saving with SNAP*ON

With reports of savings from 20 - 50% on new G-B Snap*On pipe insulation, you can readily understand the enthusiastic reception it receives in refineries, natural gasoline plants, petrochemical and chemical processing plants.

Ease of applying these one-piece molded cylinders of fine glass fibers is the key to such substantial savings. Unlike segmental insulations, Snap*On comes in 6' sections, in sizes as large as 33", and is easy to apply even in crowded quarters.

For in-plant use, Snap*On is available plain or with canvas adhered for heated piping where temperatures do not exceed 350° F. and with adhered vapor jackets for chilled piping. For outdoor service, simply snap on Snap*On and cover with weatherproofing materials.

The bigger your plant, the bigger your savings when you use G-B Snap*On. You save on original installation . . . you save on maintenance, because Snap*On is rugged and permanent . . . you save heat, because Snap*On is superior in thermal efficiency to any similar product on the market.

Write today for sample and technical bulletin.

GUSTIN-BACON Manufacturing Company

GUSTIN gb BACON

Thermal and acoustical glass fiber insulations • Pipe couplings and fittings • Molded glass fiber pipe insulation

242 W. 10th St., Kansas City, Mo.

Attapulgus Clay says **STOP!**

to
Platinum Catalyst
poisons

Attapulgus Clay keeps strict watch over your catalytic reforming feed stocks, protects you against losses caused by catalyst poisoning. It does this by effectively reducing the detrimental constituents that temporarily (sometimes permanently) foul the catalyst.

Here are the troublemakers (some need only be present at 10 parts per billion) that Attapulgus Clay adsorbs from the stream: ARSENIC—either present in the crude, or picked up from corroding tubes and equipment; LEAD—either crude-occurring or picked up; SULFUR—alkyl or aryl; NITROGEN—known to exist in some crudes, but whose source usually is in amine-type corrosion inhibitors.

Setting up this effective clay treatment safeguard can be accomplished at a surprisingly low investment—one that pays out promptly in terms of the most favorable production rate.

This is another solid example of how M&C products keep growing in value to refiners. There's always a *new place* for these versatile minerals to improve the quality and cut the processing costs of petroleum products.

NEW BULLETIN! "Preparation of Petroleum Feeds for Platinum Catalysts" *is just off press. Check the coupon for prompt mailing of your personal copy, and for other assistance, if desired.*

ATTAPULGUS PRODUCTS *from*

MINERALS & CHEMICALS CORPORATION OF AMERICA
210 W. WASHINGTON SQUARE, PHILADELPHIA 5, PA.

ALWAYS A BETTER WAY . .

MINERALS & CHEMICALS CORPORATION OF AMERICA
Dept. W, 210 W. Washington Square, Philadelphia 5, Pa.

☐ Please send me "Preparation of Petroleum Feeds For Platinum Catalysts"

☐ I'd like to talk to a representative about a specific feed stock problem.

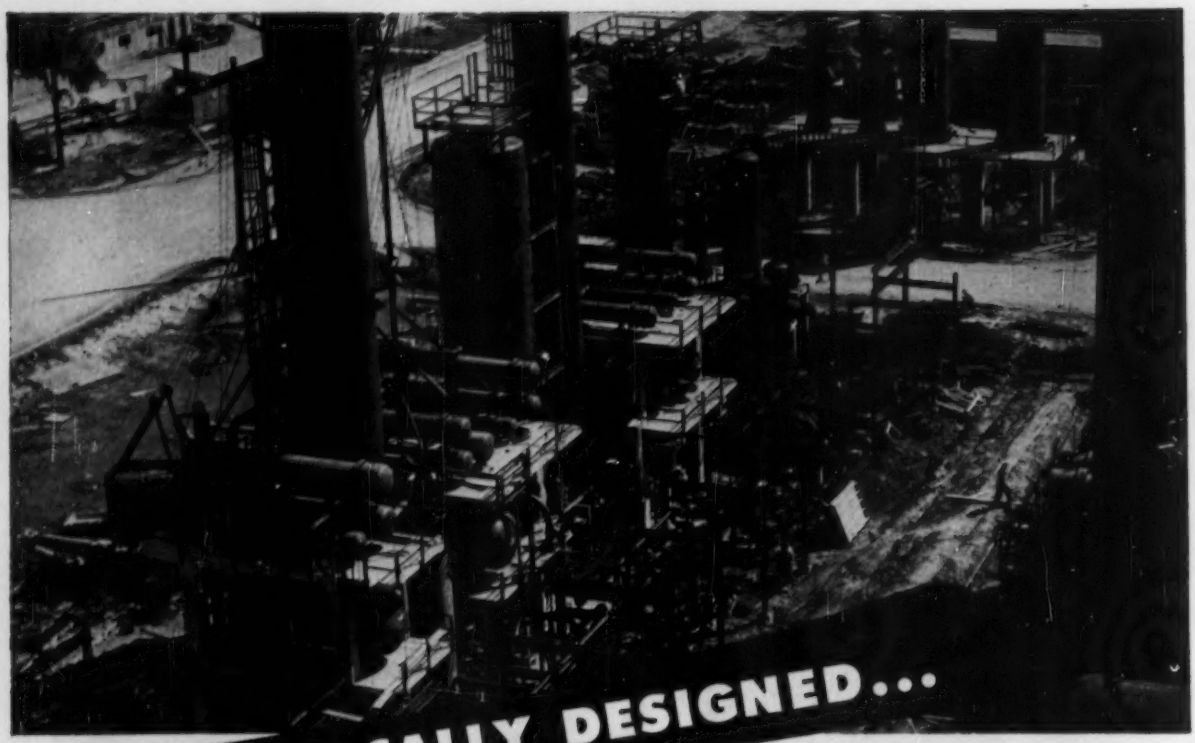
name _____ title _____

company _____

address _____

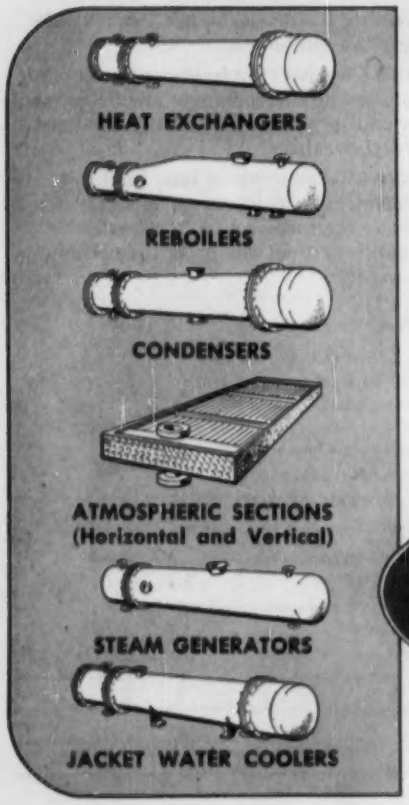
city _____ zone _____ state _____

For more data on advertised products, use Readers' Service Cards, last page.



SPECIFICALLY DESIGNED...

FOR THE REQUIREMENTS OF THE JOB!

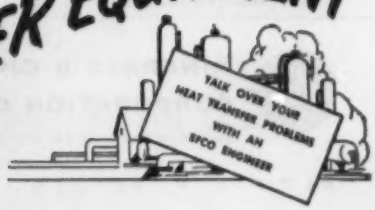


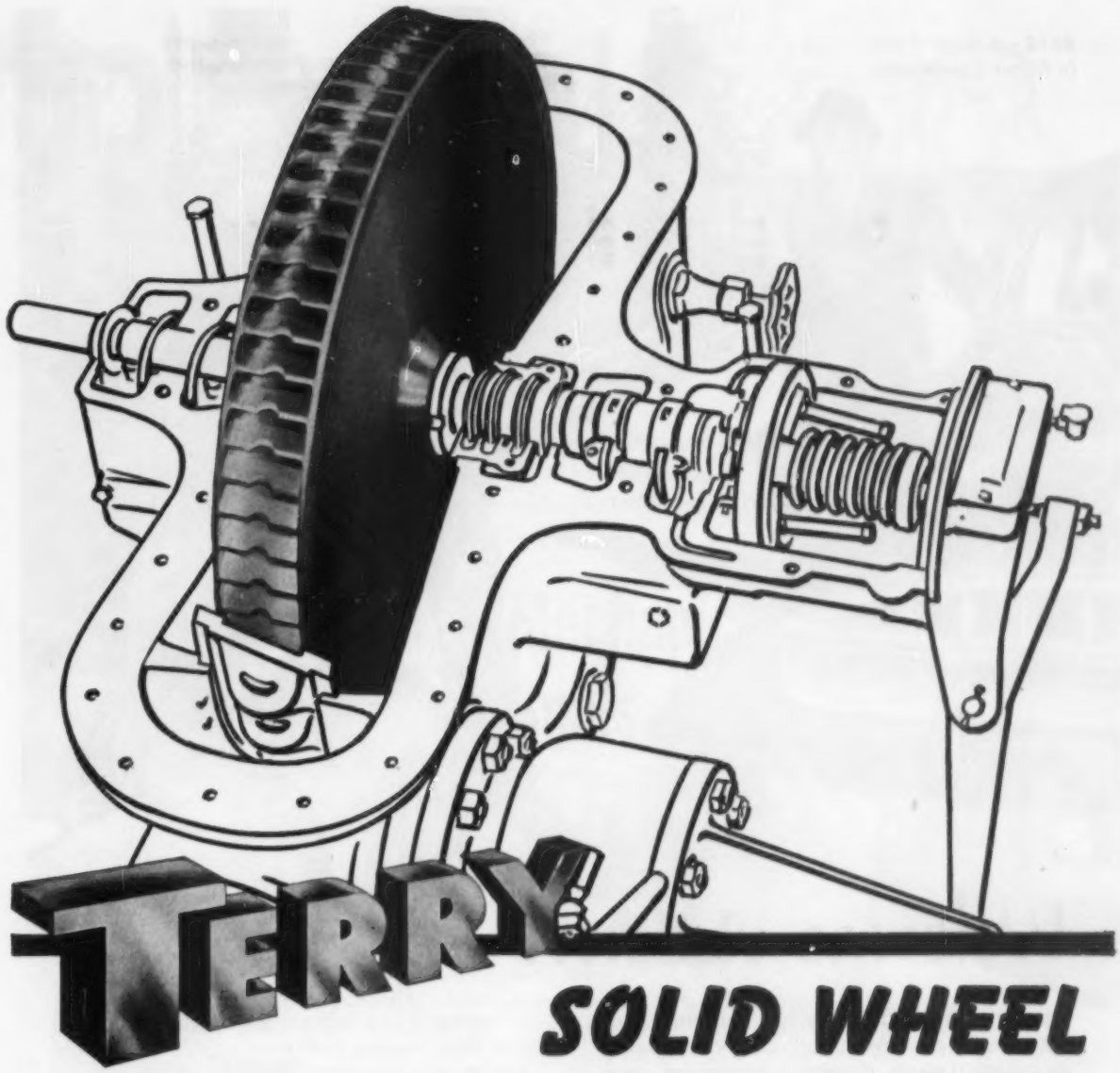
EFCO HEAT TRANSFER EQUIPMENT

● EFCO engineers can supply you with any type of heat transfer equipment to meet your specifications. Reboilers, condensers, atmospheric sections, jacket water coolers, steam generators and heat exchangers, made by EFCO specialists, are sturdily constructed to give long trouble-free service. Ask an EFCO engineer. He will be glad to help you with your heat transfer problems.

ENGINEERS & FABRICATORS, INC.
P. O. Box 7395 Houston 8, Texas

EFCO HEAT TRANSFER EQUIPMENT





SOLID WHEEL RUGGEDNESS

is your turbine dividend

The rugged construction and fool-proof design of a Terry solid-wheel turbine can save you money by keeping maintenance costs to a minimum. Usually only taken down for routine inspection, any repairs that must be made are of relatively simple nature, and cost of replacement parts is small.

The rotor of the turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

It is impossible for the blades to foul. They have large clearances and are further protected by the projecting rims of the sides of the wheel. As the side clearances are also very large, end play can do no harm.

The Terry solid-wheel turbine is an extremely reliable piece of equipment—why not write for complete details today? Ask for a copy of Bulletin S-116.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

T7-1198

For more data on advertised products, use Readers' Service Cards, last page.

BETZ • *A Great Name In Water Conditioning*

Welcome visitor...

The Betz District Engineer is a welcome visitor wherever he goes. As our personal representative to industrial plants, petroleum installations, institutions . . . plants like yours, he plays an all-important role in our continuing efforts to engineer *controlled* water conditioning.

His job carries many responsibilities. For example, he

. . . instructs your plant operators in Betz-engineered water conditioning control techniques (chemical feed, water testing, chemical adjustment, blowdown control, etc.).

. . . makes regularly scheduled visits to your plant to review operating conditions.

. . . reviews plant control and offers "on-the-spot" constructive criticism and advice.

. . . checks testing procedures, test solutions and chemical feed equipment.

. . . inspects plant equipment and visually observes the results obtained.

. . . discusses any and all water problems with you and your operating personnel.

. . . prepares and submits a complete written report before leaving your plant.

And equally important, he works closely with the Betz headquarters engineering staff to assure the individual attention required for sound, economical water conditioning.

Next time a Betz District Engineer calls, ask him to explain how Betz *completely-integrated* water conditioning service can obtain results in *your* plant. He'll be happy to give you the details.

W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories Limited, Montreal 1.

BETZ

CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

Watch your pump's Waste line

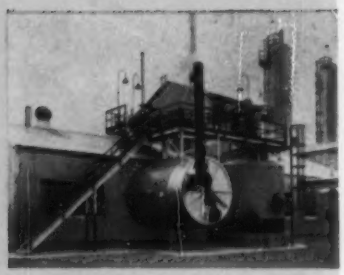
Stuffingboxes can become profit-gobbling WASTE LINES if you are using old-fashioned packing or inadequate sealing methods...

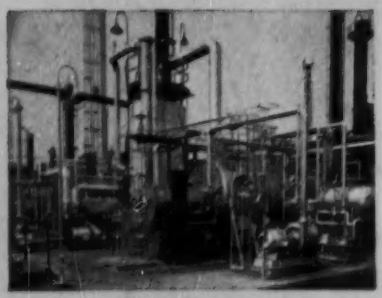
BJ Mechanical Seals

remove the waste and the worry... eliminate unnecessary leakage... prevent contamination of pumped liquid... protect against volatile liquid hazards... handle high temperatures... do away with repacking expense and repacking downtime losses. Byron Jackson makes a reliable Mechanical Seal for almost every centrifugal pump requirement. ***Byron Jackson Co.,*** *Since 1872.* P.O. Box 2017, Terminal Annex, Los Angeles 54, California, Sales Offices in Principal Cities.

You'll do better with...

For more data on advertised products, use Readers' Service Cards, last page.





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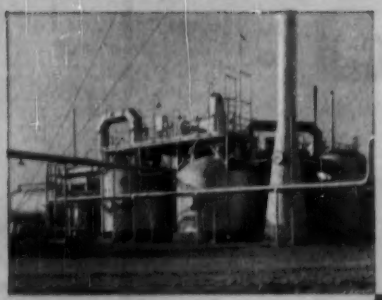
SULFUR PLANTS

by... PARSONS



Contracts for the largest H_2S sulfur recovery plants in the United States, Canada, and Europe have been awarded to Parsons. These new plants further establish Parsons' leadership in this field.

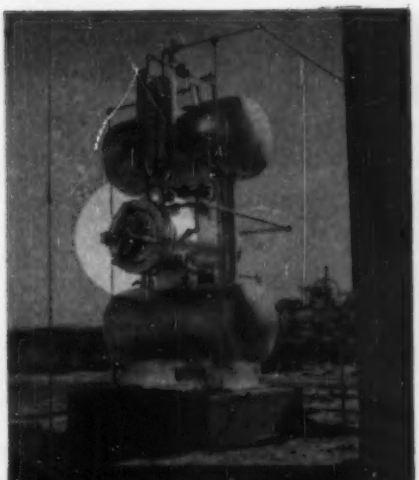
THE RALPH M. PARSONS COMPANY

Engineers • Constructors

617 South Olive Street, Los Angeles 14, California

NEW YORK • TULSA • WASHINGTON • ANKARA • BAGHDAD

BEIRUT • KARACHI • NEW DELHI • PARIS



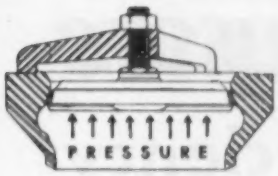
It's no effort at all to reach the internals of this Peerless Gas Odorizer through the Sillers Flex-Ring Closure.

Sillers Flex Ring Closures are utilized on these large scrubbers at a Field Processing Plant in South Texas.

Here is a typical Sillers Flex Ring Closure installation on a Sillers Scraper trap on a products pipeline in Eastern Oklahoma.

SILLERS FLEX RING CLOSURE

for faster access to the inside of pressure vessels or piping . . .



(1). Flex Ring Unit assembled as in service. (2). Spider released, gasket being removed. (3). After gasket is removed, plug is rotated to open. (4). Unit completely opened and in a fraction of time taken for conventional type closures.

SIMPLE and SAFE to OPERATE...

An entirely new design and seal principle, the SILLERS FLEX RING CLOSURE gives you many advantages and economies such as LOW INITIAL COST . . . LESS TIME IN OPENING AND CLOSING (JUST ONE BOLT) . . . TIGHTER SEAL AT HIGH PRESSURES . . . LESS WEIGHT . . . EASE OF HANDLING . . . and NO SEAL DESTRUCTION IN CASE OF FIRE. Sillers Flex Ring Closures are available in all standard sizes and can quickly be adapted for special applications.

GET COMPLETE DETAILS TODAY
SEND FOR BULLETIN NO. 3000

The perfect closure for Boilers, Evaportors, Heat Exchangers, Autoclaves, Filters, Strainers, Absorbers and all types of Pressure Vessels and Piping Systems.

FOR USE ON

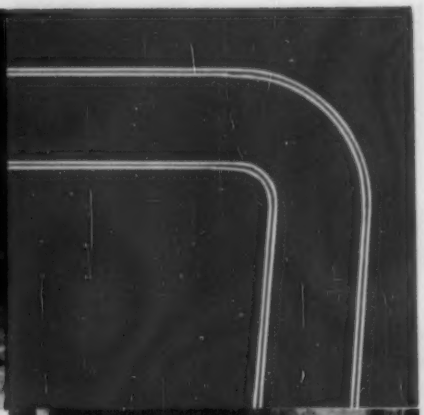
BOILERS
EVAPORATORS
HEAT EXCHANGERS
FILTERS
STRAINERS
ABSORBERS
PRESSURE VESSELS

SILLERS ENGINEERING COMPANY

Division of Peerless Manufacturing Company

BOX 13165 DALLAS, TEXAS

Representatives in Principal Cities



WILFLEY ACID PUMPS

Proven Efficiency

.....handling Acids, Corrosives, Hot Liquids and other solutions

The record of Wilfley Acid Pumps is written in hundreds of modern chemical plants throughout the world where Wilfleys are a vital factor in reducing costs and increasing production.

Absolute dependability under the pressure of round-the-clock schedules has established Wilfley Acid Pumps as the leader in this field. Available with pumping parts of machinable alloys as well as plastic to meet all requirements. Individual engineering on every application.

A Wilfley Acid Pump handling a Zinc Electrolyte

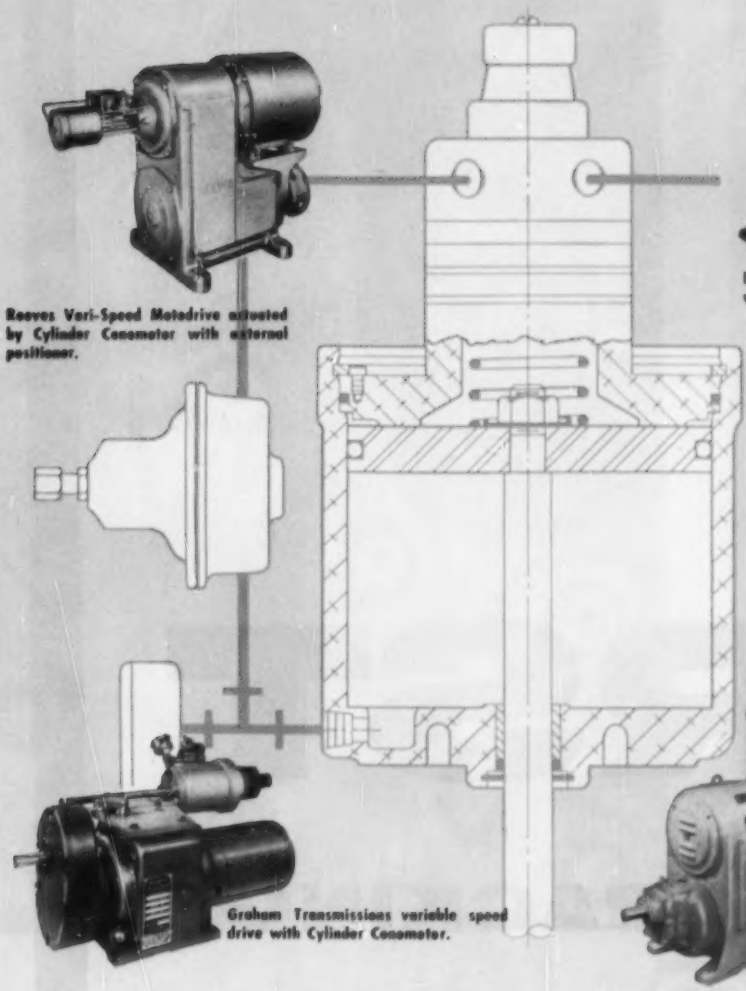
Write or wire for complete details.

Wilfley Acid Pump
"COMPANIONS IN ECONOMICAL OPERATION"
Wilfley Sand Pump

A. R. WILFLEY and SONS, INC., DENVER, COLORADO, U.S.A.

New York Office: 1775 Broadway, New York City

LOW COST, EFFICIENT Automatic Speed Control NOW AVAILABLE with the CYLINDER CONOMOTOR

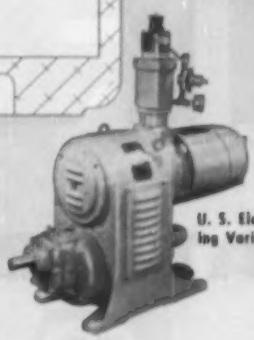


Reeves Vari-Speed Motodrive actuated by Cylinder Conomotor with external positioner.

Link Belt P.I.V. variable speed drive with Cylinder Conomotor.

Sterling Electric Motors Speed-trol with Cylinder Conomotor.

Graham Transmissions variable speed drive with Cylinder Conomotor.



U. S. Electrical Motors Varidrive featuring Varitrol Cylinder Conomotor.

For many years, industry's requirements for a practical method of controlling speed in operations involving such variables as flow, temperature, pressure, liquid level, tension, etc., could not be adequately satisfied. Now, the Cylinder Conomotor—a pneumatically positioned power operator used as original equipment on virtually all major variable speed drive units—affords low cost, dependable automatic speed control for processes . . . roll-winding equipment . . . heat exchangers . . . machine tools . . . material conveyors.

Engineers are becoming more and more conscious of the possibilities offered by automatic control of variable speed drives through pneumatic means. Pneumatic speed control combines all the advantages of simplicity, versatility and sensitivity at a low, low cost. An additional inherent feature of pneumatic control is its explosion-proof characteristic—a specified must in many industries today.

Conoflow engineers, seasoned in control techniques, can help you adapt the Cylinder Conomotor to your speed changing requirements . . . Call in Conoflow today, you'll like our personalized service.

FOR ADDITIONAL INFORMATION ON CONOFLOW CYLINDER OPERATORS WRITE FOR BULLETIN B-50-2

CC 502

Cono-Controls®

CONOFLOW CORPORATION

FOREMOST MANUFACTURERS OF FINAL CONTROL ELEMENTS

2100 ARCH STREET, PHILADELPHIA 3, PA.

FIRST

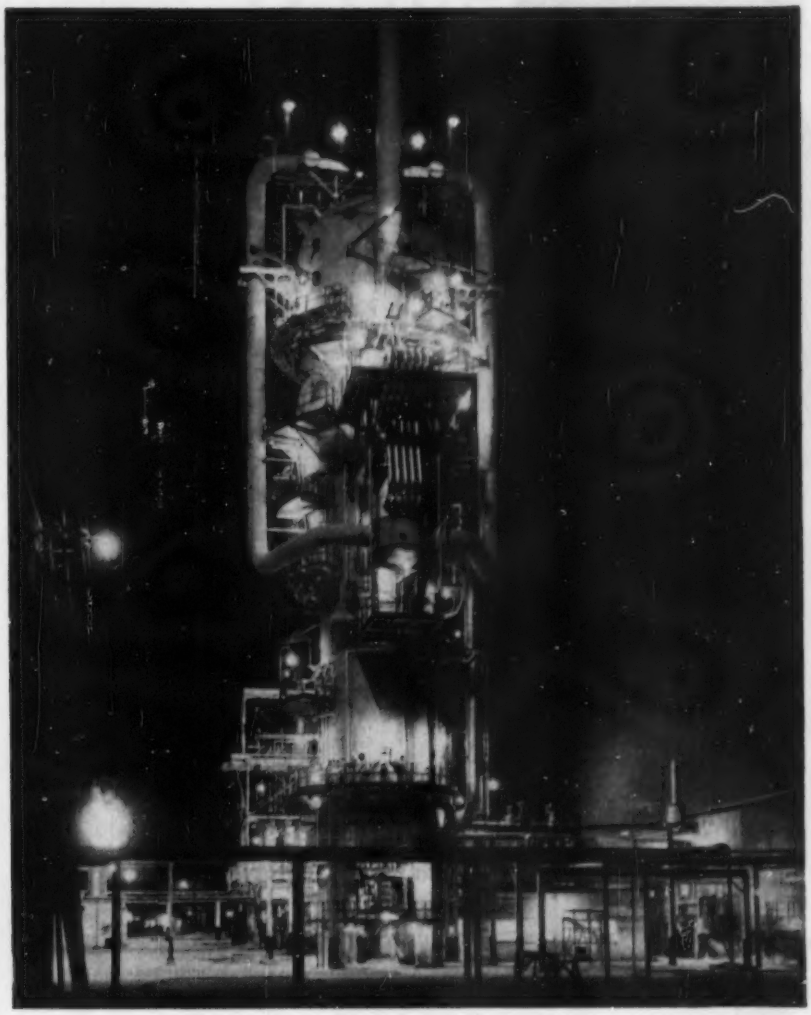
IN CAT CRACKING

With over 30 per cent of all crude today eventually becoming cat cracker feed, cat cracker design is increasingly important to refiners. The superiority of the *Fluid* Cat Cracking design is well-established by the fact that 70 per cent of cat cracking capacity in the free world is the fluid design. The M. W. Kellogg Company has engineered or erected more than half of this fluid capacity.

M. W. Kellogg has been in the forefront of Fluid Catalytic Cracking from the beginning. Starting early with continuing studies of catalysts, it worked closely with the industry in engineering the fluid principle. M. W. Kellogg's contribution in mechanical engineering made it possible to design units of capacities large enough to meet accelerated demands for higher octanes since World War II. Its long experience in constructing oil refineries enabled M. W. Kellogg to undertake the erecting of these initial units, and the even larger ones in operation today, with full confidence that they would be on stream in minimum time.

An M. W. Kellogg Fluid Catalytic Cracking unit is your guarantee of many predetermined requirements, including throughput capacity, product quality and quantity, utility cost, catalyst loss, and coke-burning capacity. From its experience in engineering and erecting many side-by-side units, M. W. Kellogg originated

For more data on advertised products, use Readers' Service Cards, last page.



The distinctive vertical construction of M. W. Kellogg's Orthoflow Fluid Catalytic Cracker—a logical development from the side-by-side model—is becoming more and more familiar on refinery skylines. Orthoflow units completed or under construction since 1951 already represent a total throughput of over 290,000 BPD.

the straight-line Orthoflow* design—which offers many extra economic advantages.

A full-color, 13-minute movie, showing how the Orthoflow works, is now being booked for showings after July 1. Return coupon for particulars and to obtain a copy of our No. 2, 1955 Kelloggram which illustrates a recent Orthoflow installation.

Refinery Process Division

THE M. W. KELLOGG COMPANY

225 Broadway, New York 7, N. Y.

The Canadian Kellogg Company, Ltd., Toronto • Kellogg International Corp., London

SUBSIDIARIES OF PULLMAN INCORPORATED

*Trademark of The M. W. Kellogg Company

Refinery Process Division
The M. W. Kellogg Company
225 Broadway, New York 7, N. Y.

☐ Send available dates for showing of your new Orthoflow film.

My preference after July 1 is (1) _____ *(2)* _____

☐ Send Kelloggram illustrating recent Orthoflow installation.

Name _____
(Title if any)

Company _____

Address _____

_____

PR-7

For more data on advertised products, use Readers' Service Cards, last page.

high quality product

boost average ratings as much as 2 octane numbers with the

Ljungstrom® Air Preheater

With waste heat recovered and returned to the furnace in combustion air, the most modern heat-transfer systems can be operated at peak efficiency.

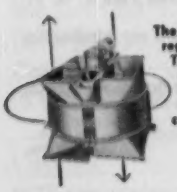
That's why you boost product quality with the Ljungstrom Air Preheater. It's heat-recovery efficiency makes possible advanced furnace designs that assure remarkably close control of processing. And finer control means a more uniform product . . . with average ratings as much as 2 octane numbers higher. One still's added income just from higher product quality is $58,000 annually.

HOW FAST IS "WRITE-OFF"?

In earnings from higher octane ratings, many refiners write off the cost of the Ljungstrom installation in less than two years. This time is cut to *nine months and even less*, when the other Ljungstrom advantages are taken into account — saves up to 20% in fuel costs . . . permits more economical furnace design, with no need for convection surfaces . . . burns many fuels you used to throw away . . . results in consistently higher through-put . . . and minimizes slag.

For more complete details on what the Ljungstrom Air Preheater can do for you . . . for an analysis of the heat recovery benefits obtainable in fuel burning equipment — call or write The Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom



The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transfered from the waste gases to the incoming cold air.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

A Special New Product!

PRODUCED BY THE TENNESSEE CORPORATION, MINERS OF COPPER, ZINC, IRON AND SULFUR.

CUPRIC CHLORIDE

TENNESSEE TC CORPORATION

For Removal of Sulfur Compounds in Petroleum Refining.

TYPICAL ANALYSES

COPPER CONTENT MIN.	36.5 %
COPPER CHLORIDE DIHYDRATE	98.0 %
WATER INSOLUBLE MAX.	0.10%
TIN, less than	0.01%
LEAD, less than	0.01%

CUPRIC CHLORIDE TENNESSEE TC CORPORATION

FOR

1. Quality Improvement
2. Cost Reduction

WRITE TODAY FOR SAMPLES

CHECK THESE *FEATURES:*

√	HIGHER COPPER CONTENT
√	LOWER MOISTURE
√	FINER PARTICLE SIZE
√	UNIFORMITY
√	FREE FLOWING
√	AVAILABILITY

Other Tennessee Corporation products, Ferric Sulfate (Ferri-Floc), Copper Sulfate, and Sulfur-Dioxide.

TENNESSEE TC CORPORATION

TENNESSEE CORPORATION

617-629 Grant Building, Atlanta, Georgia

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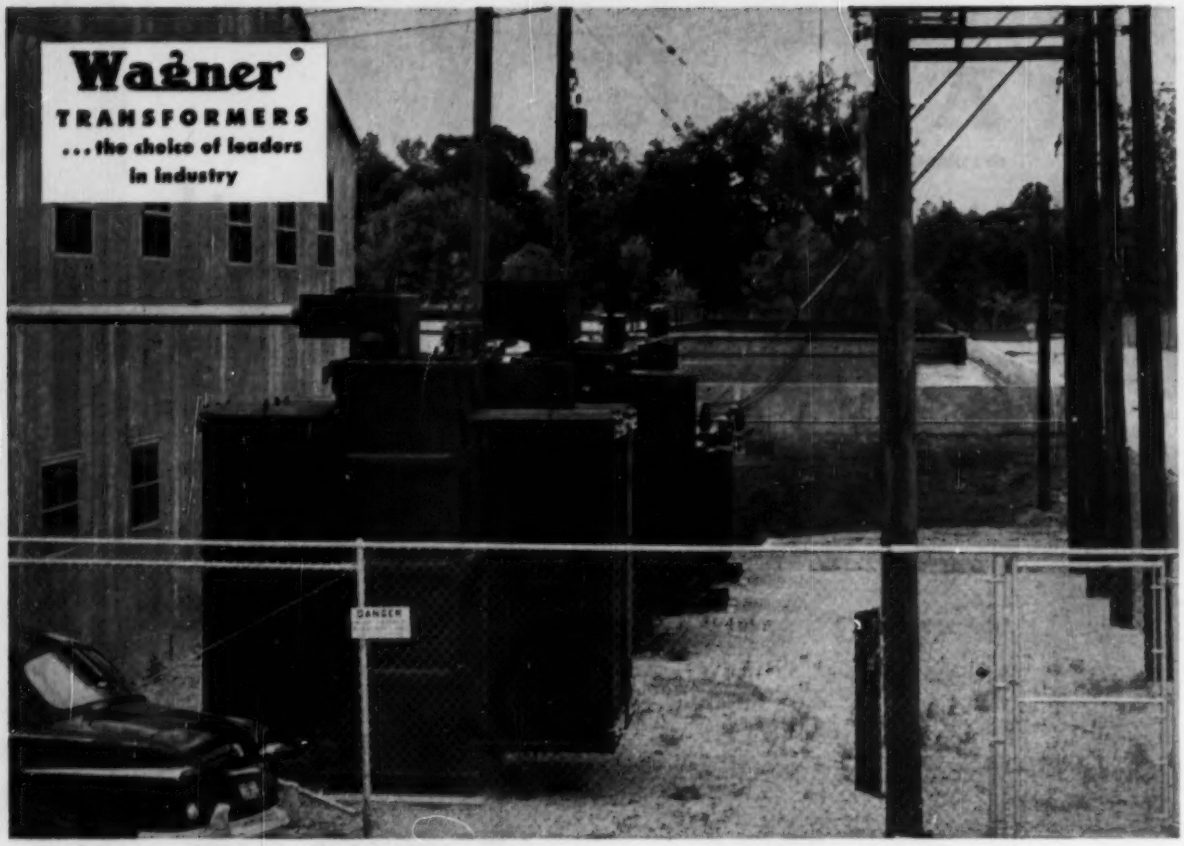
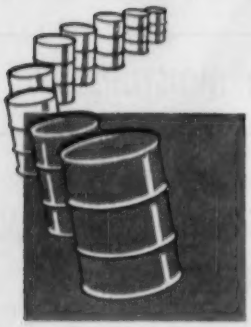




Trading Water for Oil

In Southern Illinois, over twenty oil companies have wells in the 10,000 acre Lake Centralia-Salem oil field. When production in this field dropped off, these companies banded together and decided to water-flood the field by pumping water underground through former oil producing wells to force more oil to move to the remaining wells.

What happened? The amount of oil produced has been greatly increased. Today, one well that formerly produced only 5 barrels of oil a day now yields 650!

Up to 130,000 barrels of water a day are pumped into the oil field, yet with the help of automatic devices and pushbutton control, the entire operation of the field takes only a handful of men. Electric power is at work, much of it supplied through the 2500 kva Wagner transformer, shown in the foreground above, that supplies power for equipment in the injection pump house.

Wherever electric power is used, Wagner transformers efficiently and dependably handle their never-ending job of supplying proper voltages for every purpose.

Let a skilled Wagner engineer discuss your transformer needs with you. Call the nearest of our 32 branch offices or write us direct.

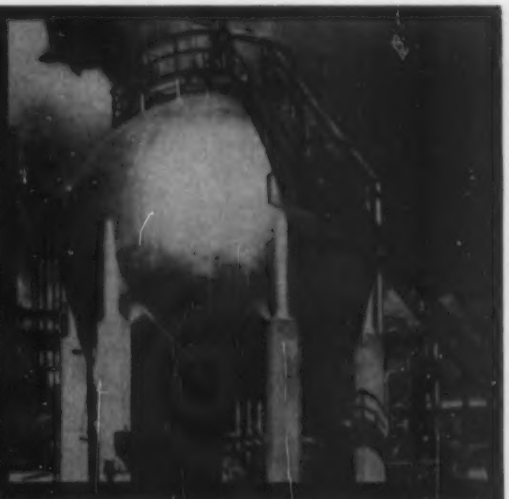
Wagner Electric Corporation
6458 Plymouth Ave., St. Louis 14, Mo., U.S.A.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

WT55-7

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

WHY IS PETRECO-DESALTED CRUDE A SAFER REFINERY CHARGE THAN A NON-DESALTED "LOW-SALT" CRUDE?



Even "low-salt" crude causes trouble. The trend in desalting performance is increasingly toward maximum removal, minimum residual salt.

Petreco desalting provides removal percentages in the 98 to 100% range, with residual salt averaging 1.5 ptb, and less.

A "low-salt" crude often contains solids such as sand, silt, rust and other plugging or abrasive materials to such a degree that they are more troublesome than salt.*

Petreco desalting effectively removes such solids and fines.

A refinery operation planned on a "low-salt" charge is greatly upset if it becomes necessary to charge a salty crude.

Petreco desalting insures smooth operations regardless of the salt and solids content of the crude charge. Petreco desalting has effectively desalted every crude charged to it.

Minute quantities of arsenic can be present in any crude, "low-salt" or otherwise, and severely impair catalysts.

Petreco desalting reduces arsenic, stops catalyst poisoning.

Regardless of salt content, "slugs" of water are sometimes picked up in the crude charge when tanks are switched. Such water-slugs play havoc with distillation equipment.

Petreco desalting eliminates the hazard of water "slugs."

The storage of crude oils in the refinery often results in the deposition of "tank bottoms." These bottoms displace storage capacity, and cause an expensive disposal problem.

With Petreco desalting in the refinery, tank bottoms can be metered into the crude charge and easily disposed of.

*In one refinery, usually charging crude containing only 5 ptb, Petreco desalting showed a rapid pay out solely on the basis of solids removed.

6 REASONS WHY PETRECO DESALTING IS PREFERRED BY SO MANY LEADING REFINERS

1
2
3
4
5
6

ELECTROFINING

PETRECO

A DIVISION OF PETROLITE CORPORATION

3202 SOUTH WAYSIDE DRIVE, HOUSTON 1, TEXAS • 1390 EAST BURNETT STREET, LONG BEACH 6, CALIFORNIA

DS-9

A Struthers Wells Type CV absorption oil heater installed at a gasoline plant of one of the largest gas transmission companies, the third installation for this company.

FIRED HEATERS

FOR

PETROLEUM REFINING

GASOLINE PLANTS

CHEMICAL PLANTS

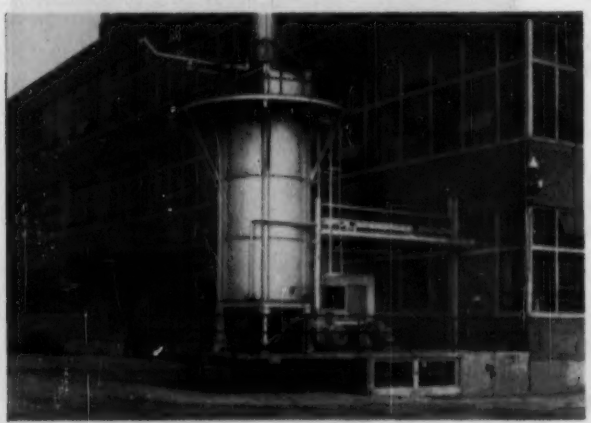
GENERAL INDUSTRIAL USE

Available in standard sizes from 500,000 to 40,000,000 BTU per hour

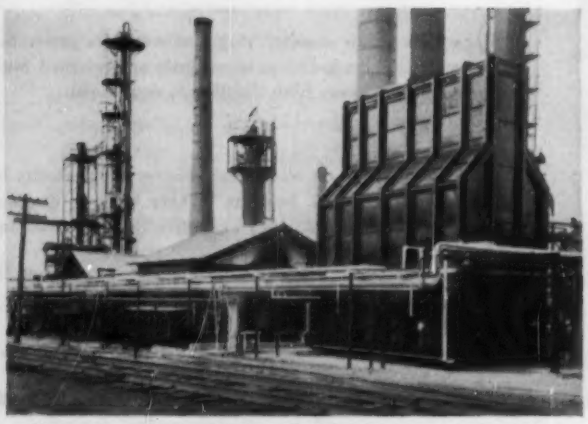
Hundreds of Struthers Wells fired heaters are now in service, in a wide range of sizes, for direct heating of petroleum oil, hydrocarbon gases, asphalt, air, oxygen, hydrogen and superheating steam, and for indirect heating using circulating heat transfer mediums. Circulating fluids used include molten metal, molten salt, Dowtherm, mineral oil, and a number of other organic materials.

In connection with heating systems, we can supply all equipment items, as a complete unit, including wired and piped panel control boards.

We also supply electrically heated units—and special heating and cooling equipment, including water heaters.



A fired heater for Struthers Wells Dowtherm heating system, one of two units installed in a new chemical plant for the production of vat dyes.



Shown above are two Struthers Wells heaters in petroleum refinery service. At right is a three-coil heater used in catalytic reforming of gasoline. At left is a heater which was installed over 23 years ago, and is still in continuous service.

STRUTHERS WELLS CORPORATION

WARREN, PA.

PLANTS AT WARREN, PA. AND TITUSVILLE, PA.

Offices in Principal Cities

Struthers Wells

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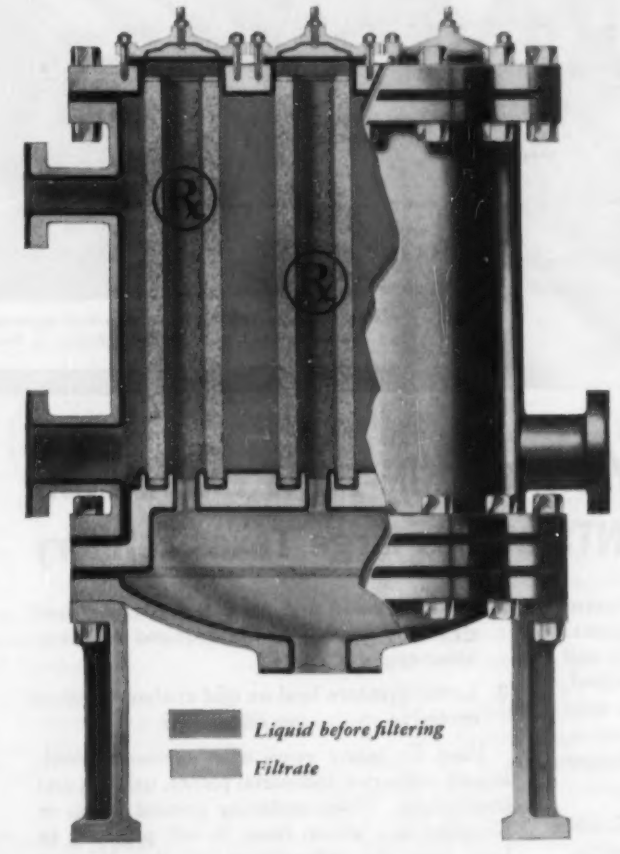
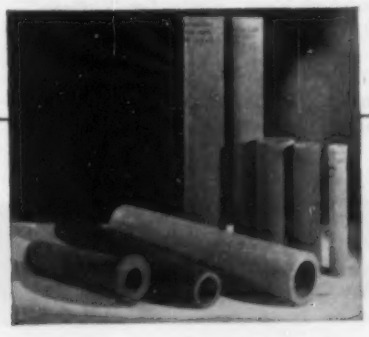
Another Norton Rx *on the job!*

Outstanding performance of Adams filters aided by Norton seamless porous tubes





R. P. Adams Co. Filters, covering many chemical filtering services, deliver sparkling clear filtrate and insure quick cleaning without disassembly. Adams filters handling acid or neutral solutions are equipped with Norton seamless porous tubes, *engineered and prescribed* for faster, more thorough filtering and backwashing.

Besides assuring fast, thorough filtering action, Norton porous tubes are extremely easy to clean by backwashing. Here are several good reasons why they excel in these two primary essentials of efficient, economical filter performance:

- Norton porous tubes are made of ALUNDUM* (fused alumina) *engineered* by Norton for chemical stability, inertness and other properties necessary to withstand acid, neutral and slightly alkaline liquors.
- Like all Norton ALUNDUM porous mediums they are made with the patented *controlled structure* process that assures even distribution of pores — for uniform passage of both filtering and backwashing liquids.
- They are *seamless,* providing unobstructed diffusion over their entire area — for further efficiency in both filtering and cleaning.

Other big advantages

of all Norton porous mediums include ease of installation and exceptional resistance to breakage and chipping. Available in sizes and open-pore ratios to meet your needs, they're *engineered* to last longer and cut your operating costs — and they're *prescribed* for a wide variety of chemical services, such as filtering water or solvents . . . cutting oils, wine, etc. . . . reclaiming cleaning fluids and industrial waste . . . and for boiler feed water treatment, carbonation, chlorination and other gas diffusion applications.

See your Norton Representative for further facts or write, describing your requirements, to NORTON COMPANY, 466 New Bond St., Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

NORTON

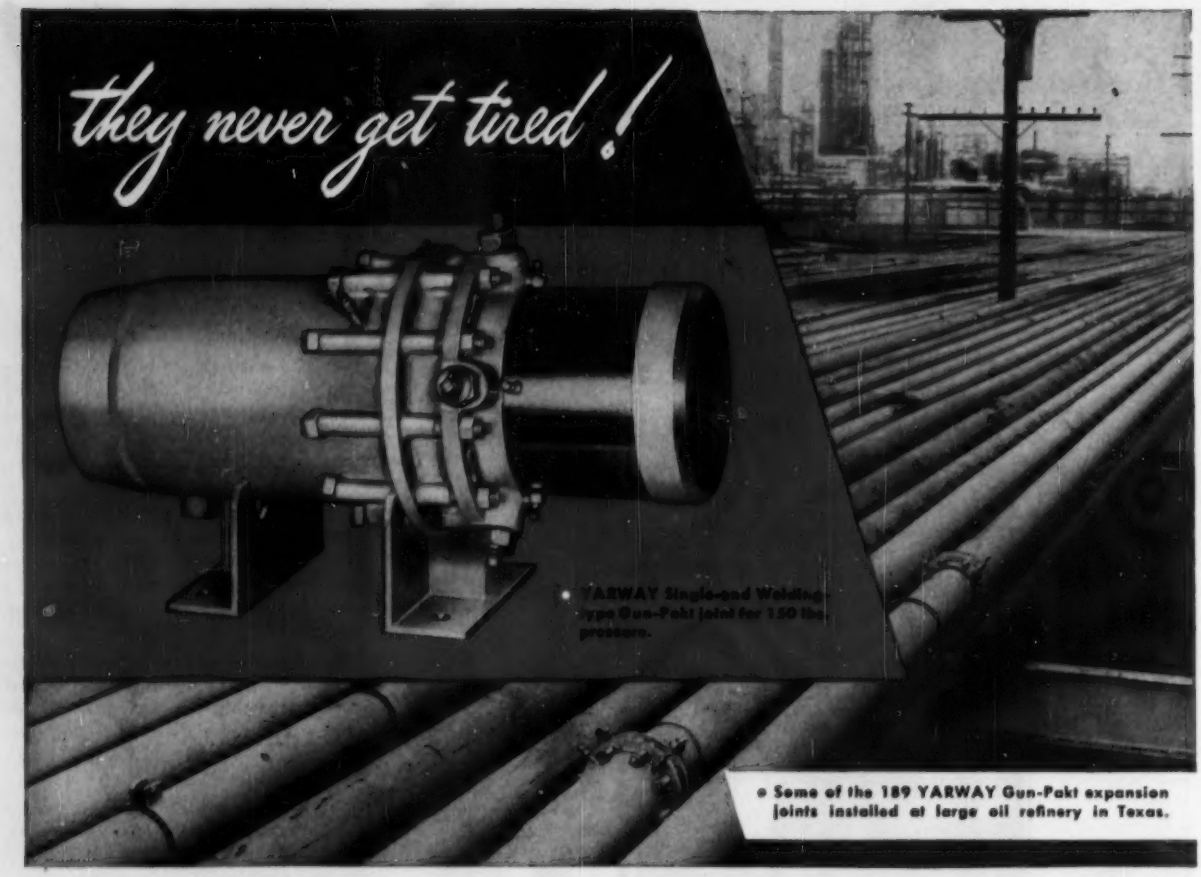
REFRACTORIES

Engineered . . . Rx . . . Prescribed

Making better products . . . to make other products better

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

For more data on advertised products, use Readers' Service Cards, last page.



No fatigue with 189 YARWAY GUN-PAKT EXPANSION JOINTS at this large Texas refinery

THEY just work and work for years and never get tired. Yarway Gun-Pakt slip-type joints simply will not fail through fatigue. They will operate smoothly, as frequently as required, over long, full traverse up to 12" single type or 24" double type or short, partial traverse, day in and day out—with never any danger of metal fatigue or failure.

This is just one of the many big advantages found in Yarway Gun-Pakt expansion joints. Other outstanding Gun-Pakt features are:

1. Can be serviced under *full* steam pressure day and night, thus avoiding costly and inconvenient shutdowns.
2. Fixed Gun-Pakt gland serves as "built in" external guide and permits less costly and rigid pipe guidance than required by many other types of joints.
3. Lower pressure load on end anchors because excessive strains are eliminated.

Used for many years with success in well-known refineries, industrial plants, utilities and institutions. When replacing present joints or planning new steam lines, it will pay you to look into the advantages of the Yarway Gun-Pakt expansion joint. Write for Yarway Bulletin EJ-1913.

YARNALL-WARING COMPANY
128 Mermaid Avenue, Phila. 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY gun-pakt expansion joints

The Mail Box . . .

Answers Dire Need

To the Editor:

I doubt if you have ever put out an edition of the PETROLEUM REFINER which answers better the dire need, for those responsible for maintaining our oil refining industry, than your March issue placing special emphasis on maintenance. I thought so well of your editorial "Engineering Procedure Needed in Maintenance" that I forwarded a copy to each of our managers and key people as I think it should stimulate their thinking and help us improve our operating costs.

W. R. Argyle
Vice President

Sinclair Refining Company
600 Fifth Avenue
New York 20

"Outstanding Issue"

To the Editor:

I have just seen the May 1955 issue of PETROLEUM REFINER which, I think, is an outstanding issue. Your coverage of the Midyear (API Division of Refining) Meeting is excellent, and if the people in the industry do not realize great benefits from the papers that were presented at the meeting, it will not be because the reading matter is not available to them.

I also wish to congratulate you on the manner in which you covered the NGAA Session.

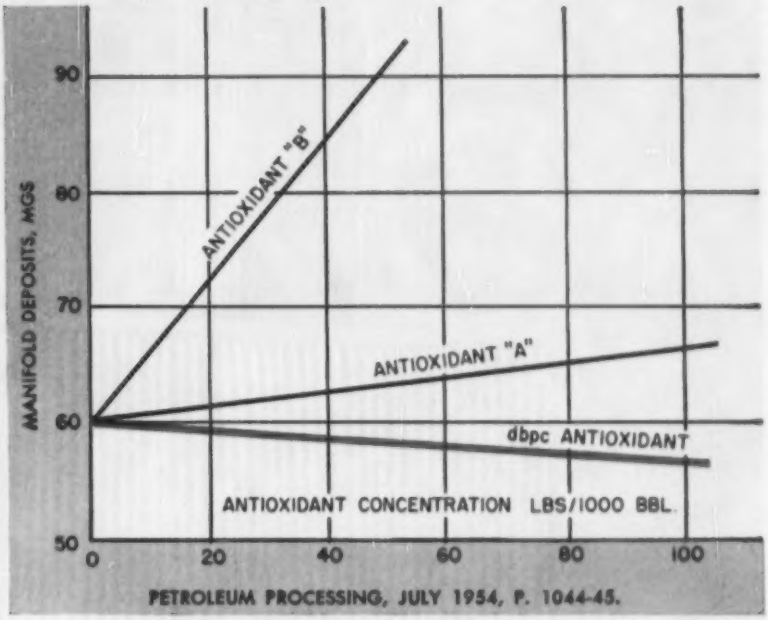
W. T. Gunn,
Director, Division of Refining
American Petroleum Institute
New York

We Omit a Zero

A reader, always on the ball, calls attention to an error on page 199 of PETROLEUM REFINER for May whereby in display type we quoted Author C. L. DePriester as saying "The methods are accurate for light paraffin hydrocarbon systems at pressures up to 360 psia."

This was contained in what we call a "pullout," used for typographical display purposes. The adjoining text was correct in referring to "pressures up to 3600 psia."

Engine Tests prove . . .



dbpc Antioxidant contributes NO manifold deposits

Three antioxidants were tested in a blend containing 60% catalytic cracked and 40% thermal cracked gasolines. The antioxidants tested were **dbpc**® inhibitor* and antioxidants "A" and "B" — other well-known commercial gasoline gum inhibitors.

The manifold test unit consisted of a specially-designed manifold attached to a single-cylinder, air-cooled engine, with provisions for control of fuel rate and temperature. The air-fuel mixture from the carburetor entered the manifold which was heated by two 500-watt, pancake electric heaters attached to the manifold exterior. Manifold temperature averaged 255° F.

dbpc (indicated in red) did not contribute to manifold deposits. Actually, it tended to *reduce* deposits. Antioxidants "A" and "B" however, *increased* manifold deposits.

dbpc is safe and easy to handle. It is economical, highly soluble in gasoline and is inert to extraction by caustic and water and the commonly used pipe corrosion inhibitor.

dbpc is also supplied in easy to handle liquid form as Impruvol 33® antioxidant.

For full information write:

*2, 6 di-tert-butyl-para-cresol

KOPPERS COMPANY, INC.
Chemical Division, Dept. PR-75, Pittsburgh 19, Pennsylvania

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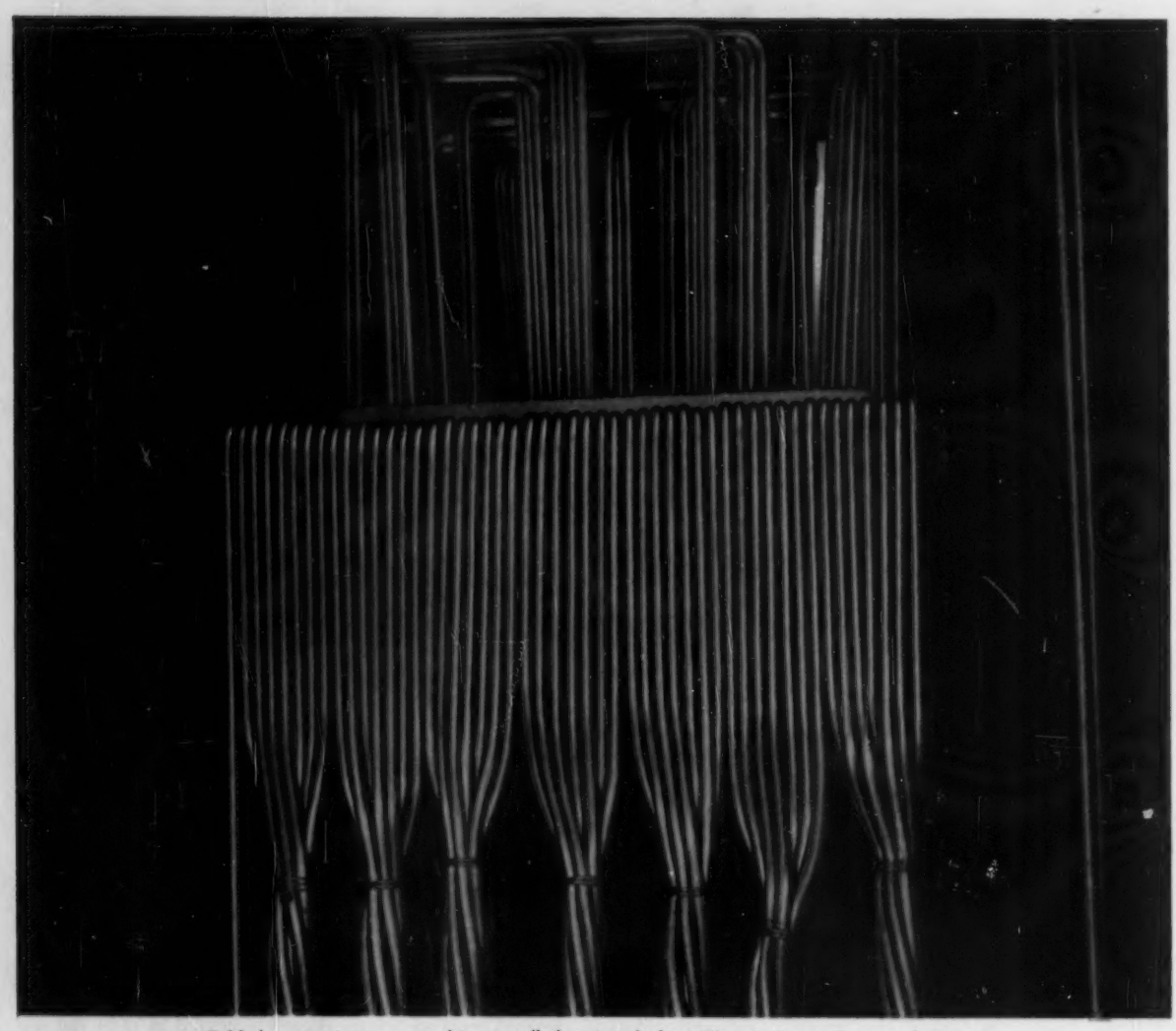


Cabled copper instrument tubing installed at Appalachian Electric Power Company's Kanawha River Station. You see it at the point where the cable divides for run-outs to instruments. Note smooth, short-radius bends.

108,000 feet of cabled copper instrument-control tubing helps keep Kanawha River Power Station humming

Hundreds of air-actuated instruments are an important part of the instrumentation control network at the 430,000-kw Kanawha River Station of the Appalachian Electric Power Company – part of the American Gas and Electric System. The size of the plant called for instrument tubing runs of up to 1,000 feet – with tubing cabled in bundles. For economical stranding, the tubing was needed in unusual lengths – without joints. To conserve space, small diameter tubing was needed. And ability to take short-radius bends without pinching was necessary.

• The 108,000 feet of Anaconda Seamless Copper Tubing was supplied in 1,000-feet lengths. Outside diameter was only ¼-inch, wall thickness only .030". Shown above are typical tube bundles as they near terminal connections.

Anaconda small-bore, thin-wall tubing is available in lengths up to 2,400 feet. It comes in long coils on reels, or cut to your requirements. Capillary tubes, restrictor tubes, Bourdon tubes, special shapes, and fabricated tubes and parts for refrigeration and air-conditioning are available in many different alloys. These include phosphorized and OFHC copper, the full range of brasses, 3,003 aluminum, nickel silvers, and certain special alloys. For more information about Anaconda small-bore tubes and special shapes ask any district sales office, or write direct to *The American Brass Company, Waterbury 20, Connecticut.* In Canada: *Anaconda American Brass Ltd., New Toronto, Ontario.* 6078

Some of the many sizes and shapes of Anaconda Small-diameter Tubes.

ANACONDA®
SMALL DIAMETER TUBES

A Quick Look at the Industry THIS MONTH

Petroleum coking operations may be stimulated by a new market for fluid coke. Development work by a major West Coast cement producer has given encouraging results for using petroleum coke and natural gas as fuel source in cement manufacture. Significance is heightened by expansion plans recently announced to increase basic cement producing capacity in U. S.

Many refiners are anxious to use coking processes, but coke disposal problem has been deterrent.

-•-

Austria has regained control of its oil properties at possible penalty of becoming net importer. Under terms of Soviet pullout, Austria must provide Russia with 8,824,000 barrels annually. Domestic needs are 9.5 million. Combined demand will strain producing capacity severely, and if nation's potential has been overestimated —as some believe—it will be forced to import part of its own requirements.

-•-

Auto and steel unions are no longer bellwethers in U. S. wage negotiations. While auto workers were going for Guaranteed Annual Wage and steel for whopping pay boost, others settled for more moderate wage hikes but pressed for increase in benefits. Raises in most industries have been from 7½ to 10 cents an hour, up 50 percent from last year's 5 to 7 cents. Some took decreases because of cost-of-living shrinkage.

Sinclair settlement is example of growing emphasis on benefits. Since this company is only one in oil industry organized on nationwide basis, CIO union uses brass knucks in negotiations to convince other workers of advantages in top-to-bottom unionization. Company fought off demands for 25-cent boost, granted 10 cents, but Oil, Chemical and Atomic Workers came out crowing over benefits gained. President Jack Knight claimed Sinclair employes now have "best sickness and accident benefits in oil industry," a point he hoped wouldn't be lost "on our members in other oil companies who bargain on a plant-by-plant basis."

-•-

Stir about octanes has quieted somewhat, but trend is still in effect. Ethyl Corporation's survey shows a nationwide average of 95.3 in May, up 0.1 number over April and 1.9 higher than in May, 1954.

-•-

Fast-growing companies in drilling-producing and pipe line branches are diversifying. Tennessee Gas Transmission Company, not long ago dedicated solely to function its name describes, later also a producer, now has added refineries at New Orleans and Denver by acquiring Bay Petroleum Corporation, and has entered petrochemical field by purchasing half interest in Petro-Tex of Houston. Month earlier, Kerr-McGee Oil Industries, Inc., producer and drilling contractor, acquired refinery, pipe line and marketing facilities from Deep Rock Oil Corporation.

-•-

Ike okayed Reciprocal Trade Agreement, and as PETROLEUM REFINER predicted last month, scratching of presidential pen on document went almost unheard midst demands that he use new power to curb imports:

• Said Sen. Martin (R., Pa.), second-ranking Republican on Senate Finance committee—importing companies are moving too slow in complying with government's intent . . . January-May crude and products imports were 19 percent higher than in 1954 period.

• Said Russell B. Brown, general counsel of IPAA—Administration should act at once to reduce imports . . . importers are due only 4.5 percent increase this year,

A Quick Look at the Industry (continued)

but first-quarter volume exceeded 1954 average by 13.4 percent.
• Said Interstate Oil Compact Commission—Congress and President should take "prompt and affirmative action" if imports aren't voluntarily reduced.

Listening to swelling furore, Rep. Cooper (D., Tenn.), House Ways and Means Committee Chairman, growled: "It will open the door to pressure and abuse which will be difficult for the President to . . . avoid."

Not everybody was so gloomy. Walter S. Hallanan, Plymouth Oil president who in past has been sharp critic of importers, predicted domestic producers can look for "some measure of relief." Senate Majority Leader Lyndon Johnson (D., Tex.) observed that importers "are taking necessary steps."

—•—

U. S. Disposal Commission apparently tripled sale price for Baytown, Texas, copolymer plant by declining last year's single bid and renegotiating on these facilities. Commission-approved bid of $7,153,000 by United Carbon Company is indicative of the excellent job already done by the Disposal group.

—•—

Three primary factors appear on ammonia-from-reformer-hydrogen scene. Synthesis gas can be produced from reformer off-gas for 25 percent less than from natural gas, leading engineering firm estimates. Trend toward higher natural gas prices reinforces favorable long-range outlook for reformer hydrogen. Many refiners are already having difficulty in disposing of reformer hydrogen in fuel systems because of dilution and furnace firing problems.

—•—

Typifying resurgence of German industrial economy is nation's recent rise to second place among world's producers of plastics. Production in 1954 was 325,000 tons, a 33 percent increase over 1953. U. S. still holds first position with 63 percent of total followed by Germany with 11 percent.

—•—

Industry was plastered with 1-cent gasoline tax hike by Texas Legislature but fended off veritable bombardment of other blood-letting measures. Nine other tax measures directly affecting industry's products were stymied. Variety of "economic waste" bills also died.

—•—

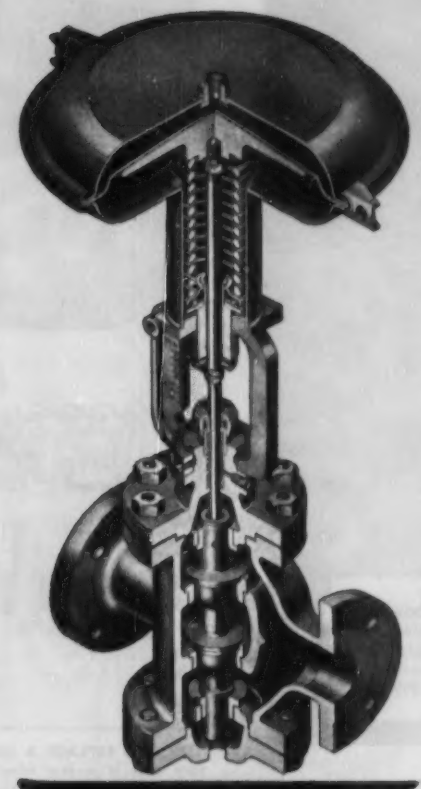
New record for free world's production of synthetic rubber this year is forecast by International Rubber Study group which met in London. Estimate of 985,000 long tons as compared to 716,400 in 1954 and previous record of 935,600 in 1953 backs up optimism of new synthetic rubber plant owners in this country.

—•—

Fifth U. S. oil refinery to operate 4 million man-hours without a lost-time accident is Pure's Smith Bluff, Texas, plant, which has more than 1000 employes. Unblemished record goes back to July 29, 1953.

—•—

Here is supreme evidence of industry's complexity: Federal Trade Commission has decided not to push inquiry into truthfulness of gasoline-additive advertising because it would require too many dollars to hire too many people to find out.



the valve that LIKES TO BE COMPARED

Is a valve positioner always required?

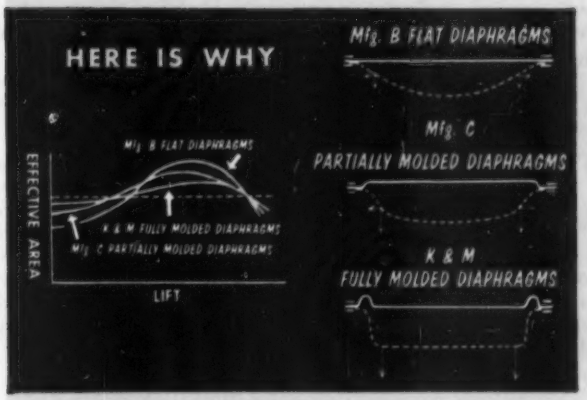
K & M provides 20-40% less positioning error. Often the need for a valve positioner is eliminated . . . because the K & M *fully* molded diaphragm gives the most constant effective diaphragm area.

K & M precision positioning also derives from long stem travel . . . lift that equals or exceeds any comparable valve . . . plus the highest power factor in the industry.

Behind it all lies one fact: K & M Control Valves are not *adapted* to high lift, they are *designed* for it. Throughout the entire range of valve travel . . . positioning is accurate and undistorted . . . control increments are finer with minimized positioning error.

Write for the K & M Valve Data Catalog, Bulletin CV-53.

77th Anniversary . . . Oldest U. S. Pressure and Level Control Valve Manufacturer



With K & M *fully molded* diaphragms, virtually all components of force are vertical. Added to this, K & M gives the highest power factor (diaphragm area x lift) for precise valve positioning.

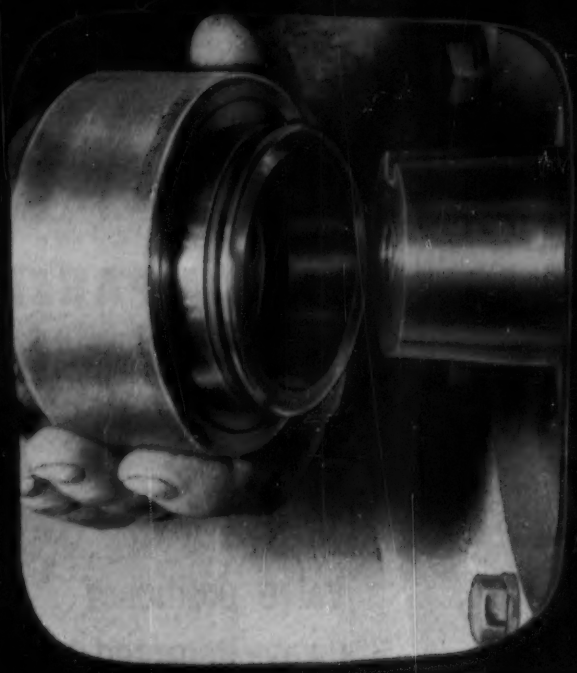
diaphragm control valves

KIELEY & MUELLER, INC.

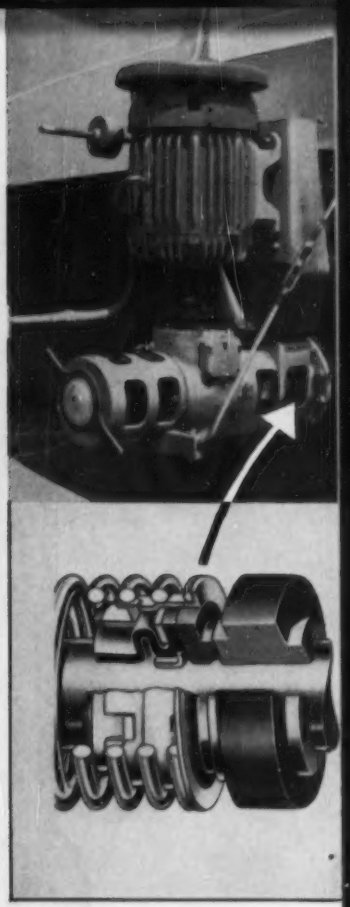
64 GENUNG STREET, MIDDLETOWN, NEW YORK

K&M

For more data on advertised products, use Readers' Service Cards, last page.



REMOVABLE SEAL CARTRIDGE is a complete unit assembly, easy to stock as a replacement, or quickly obtainable in all sizes and materials, for the simplest or most difficult operating conditions.



YOU CAN REPLACE A LIGHTNIN rotary seal in a few minutes—without special skill, without draining the tank or dismantling the mixer, without losing a pint of product. Seal is shown here without housing, to illustrate components.

Newest cost-saver in side entering mixers:

End stuffing box repacking . . . forever

with a rotary seal that's easy to replace

Now you can enjoy the solid maintenance savings of leakproof rotary sealing in a side entering mixer—without the headaches seal replacement *used* to cause.

For here, at last, is a rotary seal that runs *years* without adjustment—yet can be replaced *in a few minutes* when necessary, without draining the tank or dismantling the mixer, and *without need for special skills.*

Here's what you gain when you specify LIGHTNIN Mixers with new LIGHTNIN Seals:

1. You end leakage—for good. The seal positively will not leak during its operating life.
2. You *eliminate* the cost of repacking stuffing boxes. The LIGHTNIN Seal takes the place of a stuffing box. Under most conditions, it runs smoothly for *years* without changing.
3. You stop costly "nursing" of stuffing boxes. The seal *never* needs adjustment.
4. And most important (because it's never been possible before)—you can replace a LIGHTNIN Seal *in a few minutes,* should it ever become necessary. Only one simple *cartridge* component to remove and replace—and you're back in operation. So simple, anyone who can handle a wrench can do the replacement job *in minutes.*

Already, many oil companies are using LIGHTNIN Seals. Users report savings running into many thousands of dollars per year. Your LIGHTNIN Mixer representative can give you the full story—show you how much *you* can save. Call him today. Or get the facts by mail: Send the coupon for 8-page, fully illustrated bulletin.

Get the cost-cutting facts now... New 8-page Bulletin B-111 shows how you get maintenance-free sealing that really slashes fluid mixing cost to a new low. Send also for LIGHTNIN Mixer catalogs listed here. Free—no obligation. Just check data you want, tear out and mail to us today with your name and company address.

- ☐ B-111 LIGHTNIN Rotary Mechanical Seals
- ☐ DH-50 and DH-51 Laboratory Mixers
- ☐ B-102 Top Entering Mixers (turbine and paddle types)
- ☐ B-103 Top Entering Mixers (propeller types)
- ☐ B-104 Side Entering Mixers
- ☐ B-107 Mixing Data Sheet
- ☐ B-108 Portable Mixers (electric and air-driven)
- ☐ B-110 Condensed Catalog (complete line)

MIXING EQUIPMENT Co., Inc., 164-g Mt. Read Blvd., Rochester 11, N. Y.
In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 10, Ont.

Lightnin® Mixers

MIXCO fluid mixing specialists

Do You Need Permission to Succeed?

THE ALARM with which our industry is viewing Washington's jumped-up handling of the complex merger problem was pointed up last month by some coincidental quotes from antithetical sources.

Declared Chester F. Smith, vice president and director of Standard Oil Company (New Jersey): ". . . as times goes on the chemical business and the petroleum business will gradually merge and become almost indistinguishable."

Declared John W. Gwynne, member of the Federal Trade Commission: "It would not seem unreasonable to require corporations planning a merger to keep the government advised from the beginning of their efforts."

These two statements, while not entirely irreconcilable, certainly portend the painful chore of explaining one of the most complicated industries on earth to Potomac politicians whose essays into higher mathematics are mostly limited to counting their blessings after each successful run for office.

Gwynne's idea that industry should ask government's permission to grow is by no means casual or isolated. Sen. Sparkman (D., Ala.) has fashioned the notion into a bill which would require large firms to give both the Justice Department and FTC 60 days' advance notice of any proposed merger or sale. The proposal was given added stature by the approval of Assistant Attorney General Stanley Barnes, in charge of the Justice Department's antitrust division.

Aside from the onus in principle involved, there are one or two facts lying around which would indicate the impracticability of apologizing for aspiring to corporate success. When Youngstown and Bethlehem admitted plans for a merger, the Justice Department opposed it, as it no doubt would have done had Sparkman's bill already been made into law. And, just as they likely would have done had there been a Sparkman law, Bethlehem and Youngstown went right ahead with their plans.

So, in this case, a government advisory board on mergers would have been useless.

To view the problem from another angle, suppose the Sparkman bill had become law before the Nash-Hudson, Kaiser-Willys and Studebaker-Packard mergers. All are now considered to have been well-advised unions permitting greater competition with the Big Three. However, when the mergers were projected, it could have been argued by government advisors provided by the Sparkman law that such mergers would decrease competition by reducing the number of auto manufacturers and hence in conflict with antitrust laws.

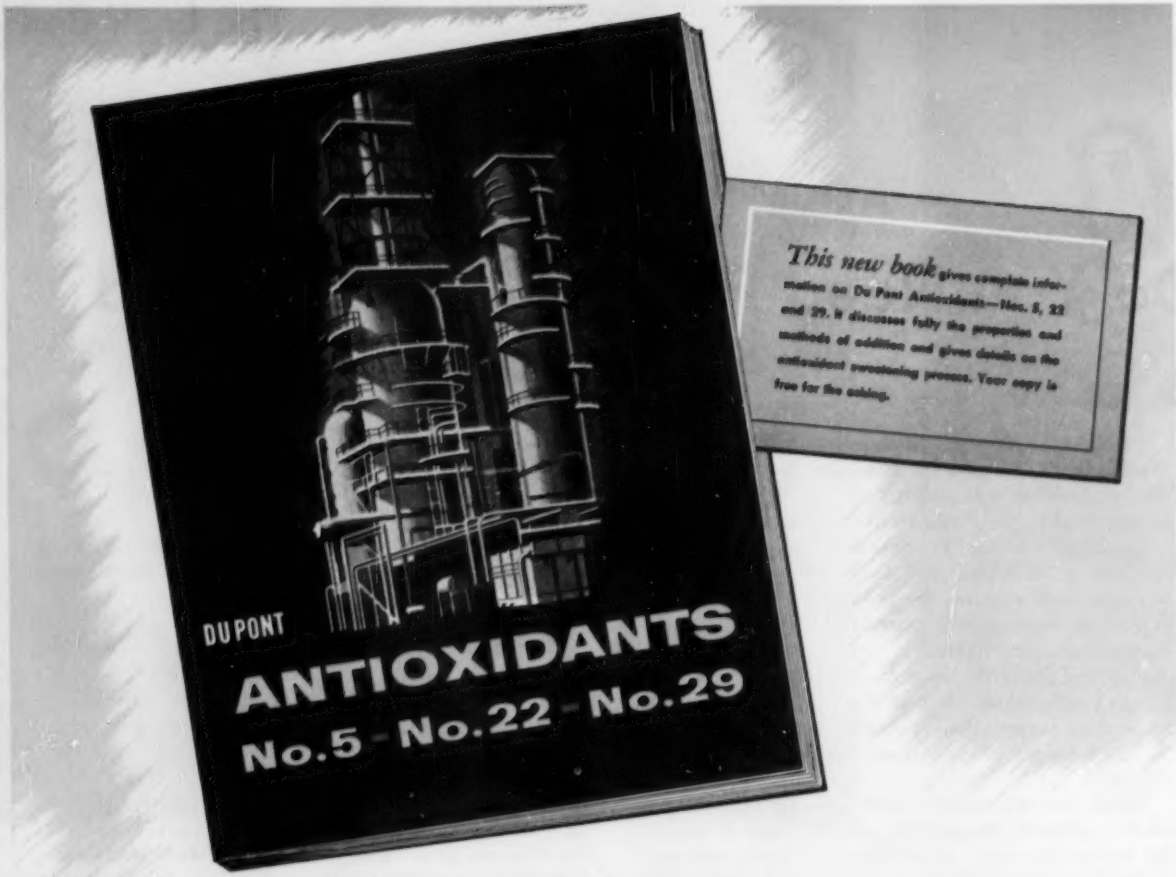
So it would seem that the true test of many mergers, either from a legal or economic standpoint, must come after the mergers take place.

FTC report—Another powerful argument against hasty legislation on the matter is the FTC merger study released recently. Though months in the making and containing 233 pages of minute detail, the report did not get around to saying the current wave of mergers is bad. Nearest it came was this: "The operation of these forces on a large scale carries with it such adverse economic effect on third parties, and on the economy as a whole, as to bring their unrestrained operation into conflict with existing law. But it added that "in policing such situations, there is sound basis for interference with the freedom of either individuals or corporations to acquire or dispose of property only where, on the basis of considered judgment, it can be shown that adverse effects on competition, and hence on the public interest, outweigh the benefits of individual and corporate freedom of action."

In attempting to set forth some guideposts to apply to Sec. 7 of the Clayton Act and the 1950 amendment which further restricted merger activity, the FTC study first listed the mergers from 1948 through mid-1954 and then attempted to analyze the reasons behind those mergers.

The study found 387 reported mergers in 1954, which was three times as many as in 1949. Nearly two-thirds of the acquisitions from 1948 through mid-1954 were made by companies with assets of $10 million or more. Firms with assets of less than $1 million accounted for less than 8 percent.

The study found that the largest number of acquisitions in the seven-year stretch were in the non-electrical machinery industry with 249 mergers and in the food products field with 243. Together they accounted for more than one-fourth of the 1773 mergers in manufacturing and mining during that period. The next ten industry groups in which mergers were most numerous were: Chemicals, 168; fabricated metals, 161; transportation and equipment, 125; textiles and apparel, 117; electrical machinery, 111; non-manufacturing, 96; mining, 81; primary metals, 78;


DU PONT
ANTIOXIDANTS
No.5 - No.22 - No.29
This new book gives complete information on Du Pont Antioxidants—Nos. 5, 22 and 29. It discusses fully the properties and methods of addition and gives details on the antioxidant sweetening process. Your copy is free for the asking.

Are you taking full advantage of Du Pont's services in connection with *antioxidant problems?*

Different gasoline stocks tend to vary in their response to antioxidants. Because of this, maintaining maximum efficiency in all your antioxidant treating operations is a continuing problem. That's why the Du Pont Petroleum Chemicals Division offers these helpful services in connection with the antioxidants we supply.

Regional Laboratory Evaluations—Before making any recommendations, one of our five conveniently located regional laboratories will be glad to study your antioxidant needs carefully. Their analysis covers the economic as well as the technical aspects of your problem.

Technical Assistance—Antioxidant problems cannot always be economically solved by laboratory analysis alone. Sometimes, in order to do the job efficiently, a major change in the treating process is called for. Because our technical representatives have had broad experience in many phases of additives work, they are often in the best possible position to help you solve a specific problem of this sort.

Du Pont Antioxidant No. 22 offers you several outstanding advantages. It is economical to use because it is both an antioxidant *and* a sweetening agent. It is highly effective in both motor and aviation gasolines and is almost completely insoluble in water or caustic. It is the only antioxidant offered for shipment in tank cars. This enables you to save about 6% on its cost.

But our recommendations are not confined to the use of any one antioxidant. The Du Pont Petroleum Chemicals Division offers *three* different types. Du Pont Antioxidant No. 5 is 50% N-normal butyl-para-aminophenol. No. 22 is N, N'-di-secondary butyl-para-phenylenediamine. No. 29 is 2, 6-di-tertiary butyl-4-methyl-phenol.

For more information about Du Pont Antioxidants and the services behind them, just get in touch with any of our representatives at the regional offices listed below. You'll find them eager to help you get maximum efficiency at the lowest possible treating cost.

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stone, clay and glass, 70; and paper and allied products, 60.

Why they merge—According to the study, factors which frequently lead to mergers include the desire for additional plant capacity or diversification of products, and the desire to serve new markets, or to gain new sources of supply. Tax savings is another prime mover.

The report had a suggestion as to how the government should test the legality of corporate unions under the law which prohibits a company from acquiring the stock or assets of another when the effect "may be substantially to lessen competition, or to tend to create a monopoly."

"Conclusions concerning the competitive consequences of particular acquisitions cannot be reached on the basis of rules-of-thumb." Thus, every merger should be individually studied to determine its effects on the market and on other companies. Any acquisition, said the report, which substantially reduces the opportunity or incentive of sellers or buyers to enter new markets, to experiment with new channels of sale or distribution, or to exercise choice among products and prices, may substantially lessen competition.

A Diamond for ASME THERE WAS a time when one of the most dangerous devices in America was the ordinary boiler. In the years from 1870 to 1910 there were 10,000 boiler explosions in the United States and adjacent parts of Canada and Mexico—more than one every 36 hours. By 1900 the rate had jumped to more than 1300 per year, or one every seven hours. Passengers on river boats were warned not to pay their fares in advance, because when the boilers exploded the crew was more likely to rescue those who still owed money to the line. And so it went.

In 1911 the American Society of Mechanical Engineers began studying the problem. As a result of millions of hours of voluntary time and effort by the members of this organization, we now have a boiler code that has been incorporated into the law of 28 states and territories, eight provinces of Canada, Australia, Mexico City, and a number of other countries and cities.

The ASME boiler code is just one of the many contributions which this organization has contributed to the safety and standardization of equipment. This year, the American Society of Mechanical Engineers is celebrating its seventy-fifth anniversary. PETROLEUM REFINER wishes to take this opportunity to join millions of Americans in wishing the society continued success in all its projects. It has done a good work and it stands to keep it going for many years to come.

Industry Supply Outlook Bright THE U. S. OIL industry is currently enjoying healthful economic atmosphere. Both gasoline and crude oil inventtries are ltwer than they were a year ago, and consumption rates are substantially greater than last year's. Gasoline's position is especially encouraging since it is in direct contract to conditions of over-supply that htve existed the past several years.

However, refining rates boosted to near record levels in recent weeks resulted in sharp gains in gasoline output. Too much of that could again lead to excesses as in the past. Several more months of reasonable refining levels would hold production of this product to realistic levels would go a long way in maintaining the current favorable position.

Charges to refinery stills averaged more than 7½ million barrels daily during the first half of June, ¼ million barrels above the May level and ½ million greater than April's runs. As a result, gasoline output during early June reached an all-time peak of 3,668,700 barrels per day, compared with 3,500,000 daily in May and 3,411,-000 during April. Additional growth in production could prove upsetting.

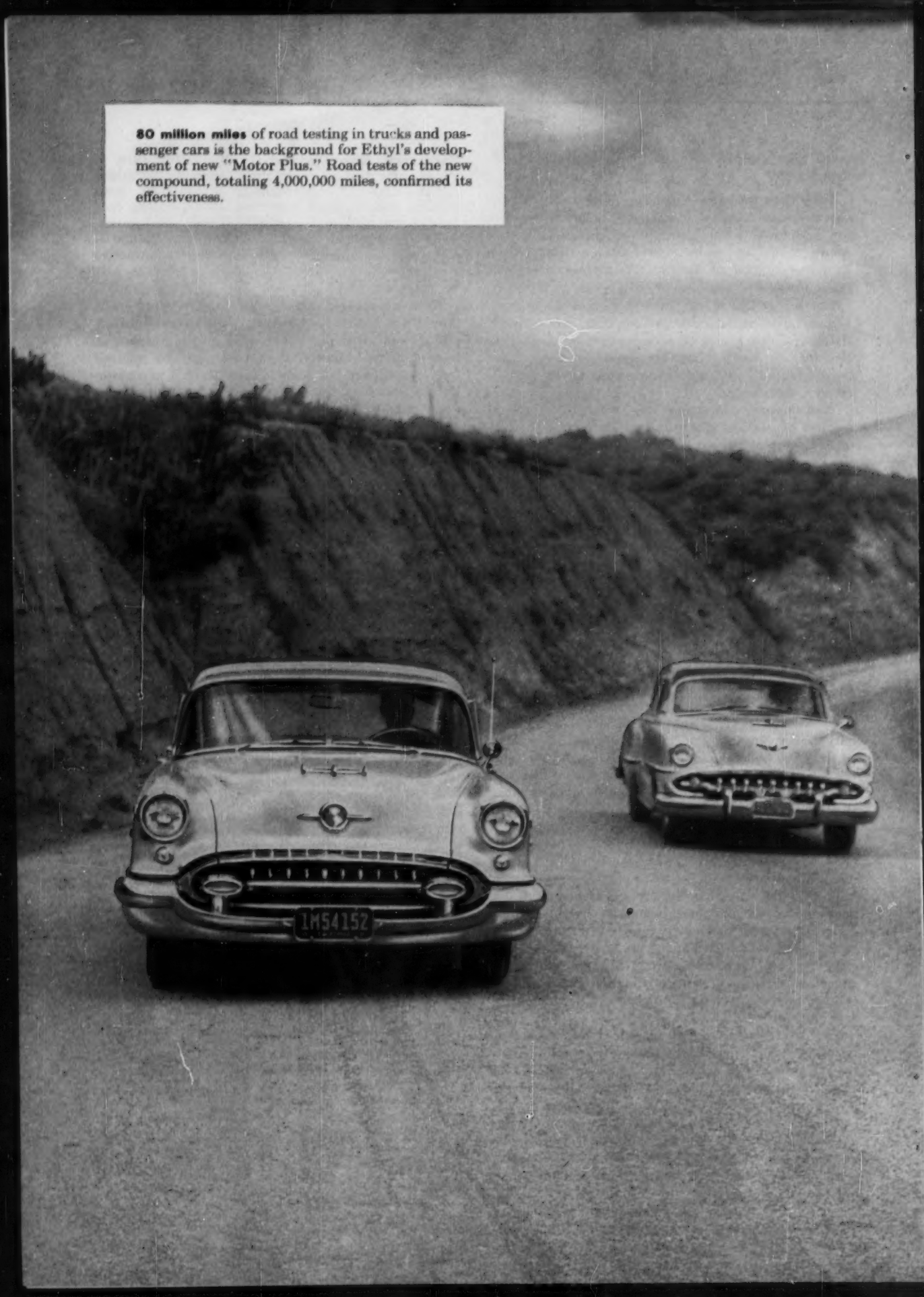
Despite increased gasoline manufacture, high consumption has caused inroads to be made into motor fuel stocks leaving them in fairly good situation. Domestic inventories totaled 165¼ million barrels on June 17, almost 3¾ million less than were in tanks a year before.

However, if industry holds production to levels that will permit gasoline to be siphoned off fast enough to lower inventories to below the 150-million level by the end of the summer demand season, there should not be too much danger of over-loading during the slack winter period.

Petroleum Is Largest GOVERNMENT figures, recently released, show that the petroleum industry is indeed the giant in the manufacturing industries. The petroleum industry is the largest, in terms of total assets, of the manufacturing group. In terms of total sales the petroleum industry is second only to the food and beverage industry. The ten largest:

In Terms of Total Assets	3rd quarter, 1954 (in millions)
1. Products of petroleum and coal (including petroleum refining)	$25,195
2. Primary metals	19,652
3. Food (including beverages)	16,957
4. Chemicals and allied products	15,162
5. Machinery except electrical	14,900
6. Motor vehicles and parts	12,231
7. Electrical machinery	9,700
8. Textile mill products	8,302
9. Fabricated metal products	7,743
10. Paper and allied products	7,543

In Terms of Sales	Year 1954 (in millions)
1. Food (including beverages)	$45,465
2. Products of petroleum and coal (including petroleum refining)	25,704
3. Motor vehicles and parts	23,022
4. Machinery except electrical	22,652
5. Chemicals and allied products	20,377
6. Primary metals	18,891
7. Electrical machinery	15,701
8. Fabricated metals	13,790
9. Textile mill products	12,509
10. Transportation equipment except motor vehicles	11,513



80 million miles of road testing in trucks and passenger cars is the background for Ethyl's development of new "Motor Plus." Road tests of the new compound, totaling 4,000,000 miles, confirmed its effectiveness.

New antiknock formula test-proved by Ethyl Research

Ethyl's new MOTOR PLUS the result of many years of work in developing improved antiknock compounds

Thirty-three years of supplying gasoline additives have taught us one fact that is perhaps the most important of all:

An antiknock compound must keep pace with all the developments in engines, fuels and lubricants. Since "Ethyl" fluid was first sold, Ethyl research has developed seven major improvements in fluid formulation to meet changing requirements in fuels and engines. The recently developed "Motor Plus" is the eighth.

Advantages to refiners

Ethyl's new "Motor Plus" offers you an improved antiknock compound which will control knock and, at the same time, lessen the problems of octane requirement increase, preignition, and combustion chamber deposits.

Our road and laboratory tests show that the new formula offers you these advantages:

Engine deposits are reduced—up to 12% (by weight).

The effects of deposits are reduced—
Knock reduced—up to 18%.
Surface ignition—up to 25%.

Exhaust valve life is increased 35%.

Extensive test background

To test-prove the effectiveness of our new formulation, we set up an exhaustive testing program eighteen months ago. Using engines of representative types, we tested the new "Ethyl" compound for 2,500,000 truck miles and more than 1,250,000 passenger car miles. In addition, we tested it in the laboratory for more than 10,000 engine hours. All tests confirmed the value of this formula in engines on the road today.

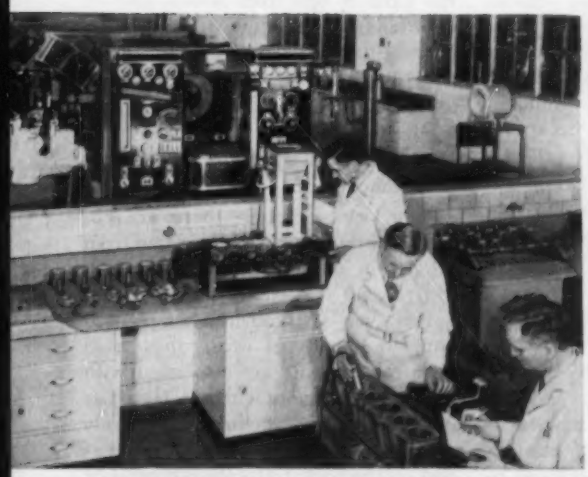
Research on antiknock compounds

Good as this new Ethyl formula is, our extensive research program continues in order to bring to the petroleum industry antiknock compounds that are best suited to the engine-fuel-lubricant environment of the future.

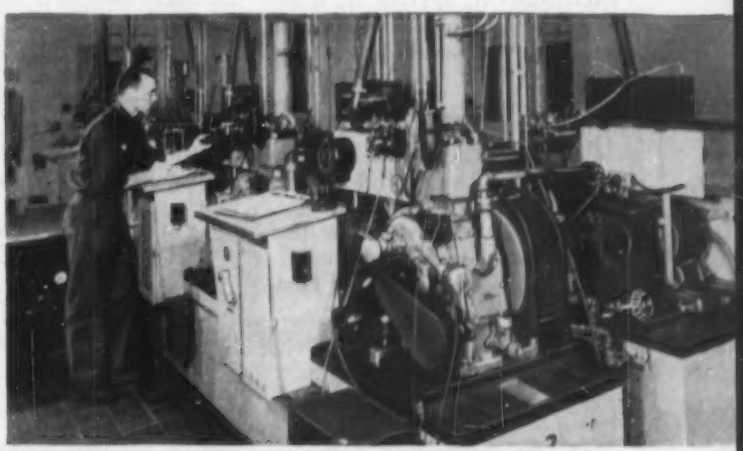
For more information about Ethyl's new antiknock compound see your Ethyl representative. He will be glad to provide the details.

ETHYL CORPORATION
Research Laboratories

1600 West Eight Mile Road, Ferndale 20, Michigan
2600 Cajon Road, San Bernardino, California



500,000 total hours of testing antiknock fluids on multicylinder engines preceded the development of Ethyl's new "Motor Plus."



350,000 hours of single-cylinder testing gave our people the necessary background to develop Ethyl's new antiknock formula. Several thousand hours were devoted to the proving of "Motor Plus" alone.

Not This ⬅

But This ⬅

MANY OCCUPATIONAL hazards can be controlled by engineering methods. For example, the handling of dry chemicals, left photo, may result in exposures to toxic materials through inhalation of dust. At right, the worker is protected by a well-designed exhaust system.

Industrial Hygiene: Newest tool in safeguarding health of industry employes.

Management is recognizing value of science which stresses prevention over cure.

Al Reese, REFINER Staff

INDUSTRIAL HYGIENE is petroleum management's newest tool in safeguarding the health of employes.

So new is the science to the oil industry that only eight companies employ it.* In the petrochemical industry and others its acceptance has been more rapid.† The American Industrial Hygiene Association, which was organized in 1939 with a membership of 100, now has an enrollment of 900.

Industrial hygiene typifies the modern health concept of stressing prevention over cure through application of engineering principles. As defined by N. V. Hendricks of Esso Research and Engineering Company, new president of AIHA, its objectives are "to anticipate, locate, measure, evaluate and control those environmental factors which may affect the health, well being or efficiency of the worker."

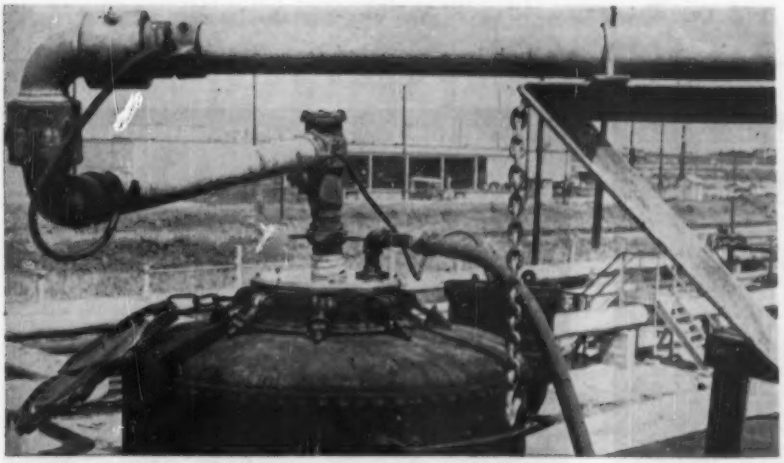
The science has application in every branch of the industry:

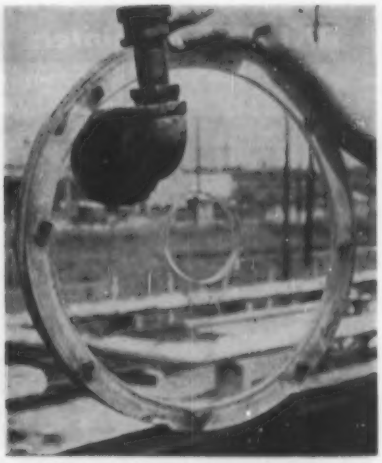
- In research and development there may be exposures to new and toxic materials which must be controlled.
- In the design stage of new facilities or the modification of existing ones there are potential exposures to the process operators which can be controlled by the application of engineering principles.
- In drilling-production there are a multitude of problems ranging from the use of radioactive materials to the possible effects upon hearing from noisy machinery.
- In transportation there are environmental problems varying from inhalation of toxic volatile materials to irritating skin contact.

However, as Hendricks has pointed out, "the bulk of environmental health problems are associated with refining and manufacturing. Here the industrial hygiene engineer must study all existing operations, both process and mechanical, to locate potential or

* Phillips Petroleum Company, Standard Oil Company of California, Imperial Oil, Ltd., The Texas Company, Socony Mobil Company, Esso Standard Oil Company, Esso Research and Engineering Company, Humble Oil & Refining Company.

† Pioneers in recognizing the science were E. I. du Pont de Nemours & Company, The Ethyl Corporation, Dow Chemical Company, Monsanto Chemical Company, American Cyanamid, Union Carbide and Carbon Company and affiliates.





ESCAPE OF SOLVENT vapors around tank-car loading is prevented by installation at left. This controls worker exposure to solvent vapors and prevents some product loss. Details of dome cover are shown at right.

actual exposure, measure them, and assist in their control."

Training the Hygienist—In an industry of increasing mechanical and process complexity and with a growing multitude of potentially hazardous new products, both used and manufactured, the hygienist's task necessitates considerable training, academic and practical. The usual approach to the profession is scholastic instruction in chemistry, chemical engineering or a closely related science, followed by post-graduate work in industrial hygiene. Of the several major schools presently offering graduate work in the field, those with the best established and recognized programs are Harvard, the University of Michigan, and the University of Pittsburgh.

Then come months of field training in which the hygienist learns to recognize the hazards of his industry through knowledge acquired of processes and materials. The trainee makes preliminary surveys, collects atmospheric samples by various means, makes analyses and dust counts in the laboratory. He must become familiar with the evaluation of these quantitative findings and prescribe practical engineering control methods, if needed.

Another approach to industrial hygiene as a career, and one not uncommon in the petroleum industry, is post-graduate college study by technically trained personnel who have become interested in the work after having spent some time at work in the industry.

The Safety Team—The industrial hygienist is a link between the safety department, with which he works closely, and the medical department, of which he is usually a member. Duties of the hygienist and the safety engineer are so contiguous as to frequently overlap, thus creating a joint responsibility for safe and healthful working conditions. Both are rated as service or staff personnel, meaning they support and advise—almost never instruct—the line supervisor in operating his units in a non-hazardous manner.

The safety engineer contributes to the hygiene program by detecting suspicious symptoms of atmospheric exposure of an employe or by passing along complaints of employes suffering discomfort in their work. In return, the hygienist may communicate his findings on atmospheric contaminate or other health hazards to the safety engineer, who will then provide the necessary personal protection equipment through regular channels.

The hygienist's identification with the medical department is highly advantageous because of employes' natural inclination to look to medical men for health guidance, which includes opinions on the safety of the atmosphere in which they are employed. Further, employes repose trust in the confidential nature of medical procedure, which is of help to the hygienist in obtaining certain tests, *e.g.*, urinalyses. In return, the hygienist's evaluation of work environment is often necessary to medical personnel in diagnosing the influence and effect, if any, on employes' health.

Management's Role—Management is another group whose understanding cooperation is required for the successful application of industrial hygiene. As cited by James W. Hammond, Humble Oil & Refining Company's hygienist, before the API Safety and Fire Protection Committee at New Orleans, management's responsibility is contained in these axioms:

1. Unless and until the employer has done everything within reason to provide a healthful working environment, the worker can do little to protect himself, although he is willing to do his share. The employe looks to management for guidance, and unless the employer takes every reasonable precaution to remove danger from the environment of the worker, the latter is not likely to recognize the danger until it is too late.

2. The employer should exercise safeguards which will remove or minimize the human factor in the control of a health hazard. Many injuries from occupational hazards are due to the failure of the employe to use proper equipment provided for his protection. For example, the employe who may neglect to use a respirator nevertheless may be reasonably safeguarded by management through control of the hazard by mechanical or exhaust means.

3. Employes should be told of any danger inherent in materials with which they come in contact. Ordinarily, the employe will respond to management's concern for his well

See INDUSTRIAL HYGIENE page 238

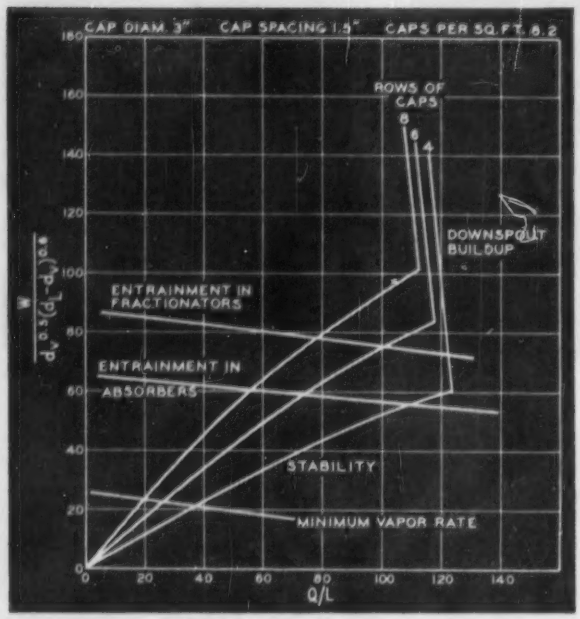


FIGURE 1—Operating limits for bubble cap trays (3-inch cap diameter, 1.5-inch tray spacing, and 8.2 caps per square foot.)

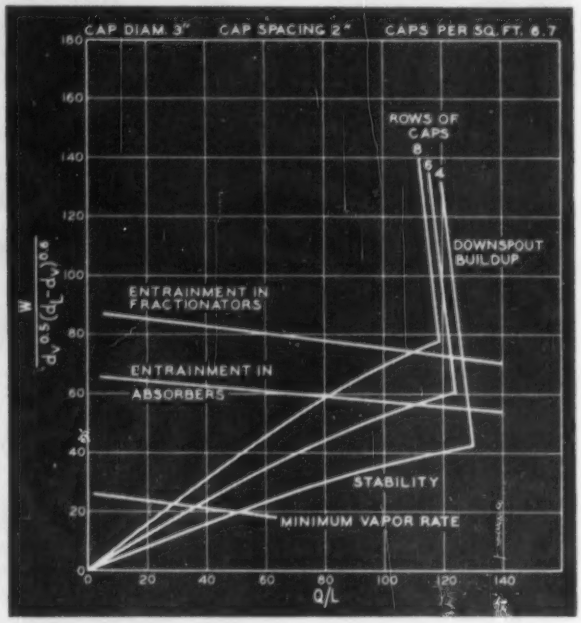


FIGURE 2—Operating limits (3-inch cap diameter, 2-inch cap spacing, 6.7 caps per square foot.)

New Approach to Tray Design

Simple charts show the relative effects of the vapor and liquid flows as well as of the physical characteristics of trays.

Paul Munk,
California Research Corporation, Richmond, Calif.

VERY COMPLETE trays design information can be readily obtained from charts showing regions of satisfactory operation, as developed in this method which takes into account the interdependence of vapor and liquid flow. Tested in commercial operation, the trays designed by the proposed method operated satisfactorily in every instance and trays modified according to the charts showed marked improvement in operation.

Preparation of Design Charts—The variables considered in preparation of the charts are the vapor flow as limited by the entrainment and the contacting efficiency, the liquid flow as limited by the downspout capacity, the relative effect of vapor and liquid flow rates on the stability of tray operation and on the distribution of vapor, the size of bubble caps, and the cap spacing.

In the present method, the cap is considered the limiting factor in handling of the vapor load. In most methods, the total cross-section has been used to determine the vapor loading which disregards the effect of slot velocity on entrainment. The number of caps provided on a tray should be within the limits as set by excessive entrainment at the maximum vapor rate and proper vapor distribution and velocity for mixing of vapor and liquid at the minimum vapor rate.

The liquid flowing across the tray determines the length of the overflow weir and the size of the downspouts. The height of the liquid build-up in the downspout is the most direct measure of the liquid carrying capacity of a tower. However, proper allowances must be made in the design to account for entrainment of vapor in the liquid and for foaming. For towers operating with high liquid

Meet the Author

PAUL MUNK is a research engineer engaged in process design of petroleum refineries. His work in the California Research Corporation laboratories involves numerous problems in distillation and column design. Munk joined the research company following a tour in the Navy. A chemical engineer, he was graduated from the College of the City of New York in 1944 and completed a master's degree from the University of California in 1950.

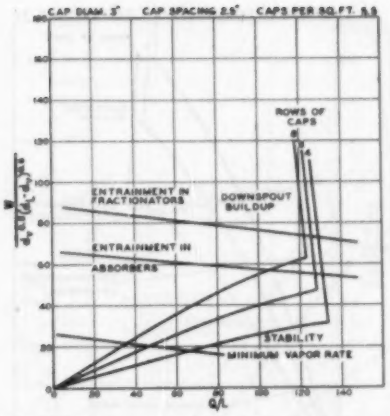


FIGURE 3—Operating limits (3-inch cap diameter, 2.5-inch cap spacing, 5.5 caps per square foot).

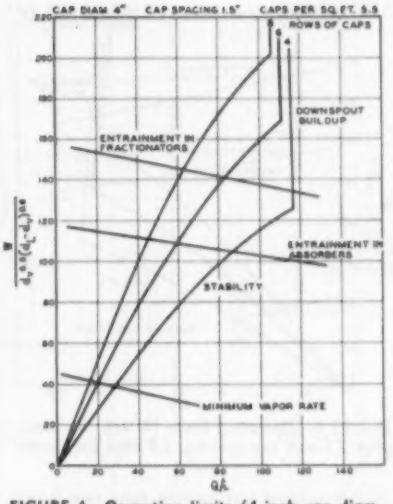


FIGURE 4—Operating limits (4-inch cap diameter, 1.5-inch cap spacing, 5.5 caps per square foot).

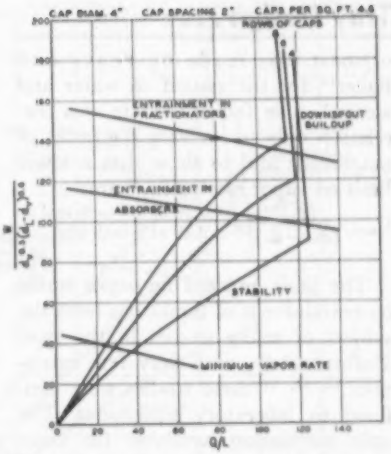


FIGURE 5—Operating limits (4-inch cap diameter, 2-inch cap spacing, 4.6 caps per square foot).

rates, careful attention must be given to the hydraulic gradient, because excessive gradient results in uneven vapor distribution and, in extreme cases, in dumping of liquid through caps or even in flooding of the tower.

Development of Method—The number of variables involved in the mechanical design of a bubble cap tray is so great that it is necessary to fix arbitrarily several of them. This study is limited to cap diameters of 3, 4, and 6 inches and cap spacings of 1½, 2, and 2½ inches between caps. The details of caps and trays common to all layouts are listed in Table 1.

Pressure drop through the bubble caps figures prominently in the correlations. The work of T. C. Dauphine[8] is the most complete and most widely applicable. The following equations are derived for the three sizes of caps used in the correlations, on the assumption that the annular area, the riser area, the slot area, and the reversal area are equal to each other and equal to one-half of the inside area of the cap.

For 3-inch caps:

$$H_c = 1.939\left[\frac{U(d_v)^{0.5}}{(d_L - d_v)^{0.61}}\right]0.82 \qquad (1)$$

For 4-inch caps:

$$H_c = 2.234\left[\frac{U(d_v)^{0.5}}{(d_L - d_v)^{0.886}}\right]0.84 \qquad (2)$$

TABLE 1
Design Details Common to All Caps and Trays

Caps:	
Slot Height, Inches	1
Skirt Clearance, Inches	0.5
Spacing Pattern	Equilateral Triangles
Static Seal, Inches	0.5
Trays:	
Overflow Weir Shape	Rectangular
Overflow Weir Height, Inches	2
Inlet Weir Clearance, Inches	2
Spacing, Inches	24

For 6-inch caps:

$$H_c = 2.768\left[\frac{U(d_v)^{0.5}}{(d_L - d_v)^{0.86}}\right]0.86 \qquad (3)$$

The hydraulic gradient across a plate is calculated by an equation derived by Davies[9]:

$$Q = \frac{2.15C_d f(h_g)^{0.5}}{(r)^{1.5}}\left(h_g(1.5r - 1.4) + 3r\left[d_o + S(a - 1)\right]\right) \qquad (4)$$

The hydraulic gradient calculated from this equation is corrected by the method of Davies for the vapor rate if this is different than that for which the equation has been derived.

In the present correlation the limit of stability is placed at the point where the wet cap pressure drop, calculated for even distribution of vapor, equals the hydraulic gradient, as calculated by Davies' equation, even though other investigators,[12,14] found that this is conservative in most cases. Experience with operating columns shows that satisfactory efficiency can be obtained when trays operate at this limit, but vapor distribution will improve further if the wet cap pressure drop is larger than the hydraulic gradient.

The height of the liquid over the overflow weir is calculated by the Francis formula for rectangular weir:

$$h_w = 0.0918\left(\frac{Q}{L}\right)^{2/3} \qquad (5)$$

The downspout contraction loss is calculated as a loss through an orifice with a discharge coefficient of 0.59 as recommended by Cicalese et al.[5] The equation is:

$$h_d = 0.36\left(\frac{Q}{449A_d}\right)^2 \qquad (6)$$

The build-up of the liquid in the downspout is the best indication of the liquid load,[7] because it shows how much free space, if any, remains in the downspout under column operating conditions. By noting the factors contributing to the build-up, steps can be taken to improve the design so that nothing in the tray layout causes unduly high downspout build-up. The height of the liquid in the downspout above the level of liquid on the tray next to the downspout is the sum of the liquid head equivalent to the pressure drop across the tray and the downspout contraction loss, as follows:

$$B = (H_c + h_w + b + h_e/2) + h_w + h_g + h \qquad (7)$$

In this correlation, the limiting downspout build-up is set at two thirds of the tray spacing at low liquid rates. To compensate for the effect of froth at high liquid rates[19,22] the allowable build-up in the downspout is arbitrarily lowered 1-inch for every 10 gpm per foot of weir length above a liquid rate of 65 gpm per foot which corresponds to a 2-inch total seal over the slots. In this correlation the residence time in the downspout is not considered, but for most designs this will be adequate as long as the overflow weir length equals 75 percent of the column diameter or more. In special cases the residence time in the downspout must be checked separately.

Low vapor rates result in poor contacting efficiency, uneven distribution of vapor,[5] pulsation,[14] or even dumping of liquid through the risers.[1] While this lower limit has been recognized by many, the only quantitative meas-

urement was made by Peavy and Baker[18] for the system of water and alcohol. The limits, used in this correlation only to indicate the order of magnitude and to show that a lower limit on vapor rate exists,[10] are:

$$U_{max.}\frac{(d_v)^{0.5}}{(d_L - d_v)^{0.5}} = \begin{matrix}0.29 \text{ at 0.5-inch seal} = \\ 0.20 \text{ at 2-inch seal}\end{matrix} \quad (8)$$

The limit imposed on vapor traffic by entrainment of liquid has been the subject of many studies in the past. Unfortunately, with very few exceptions,[13, 17, 21] these studies were confined to laboratory equipment. The only correlation available for commercial columns is by Souders and Brown,[21] which is conservative. Most investigators have tried to correlate entrainment with superficial velocity, but some[11, 20, 22] have shown that the entrainment also depends upon shot velocity. The present correlation employs the slot velocity as a criterion of entrainment instead of superficial velocity. To establish a maximum allowable slot velocity, the correlation of T. C. Dauphine[8] is used:

$$U_{max.}\left(\frac{d_v}{d_L}\right)^{0.5} = 1.44$$

The limits are the velocity which would completely open the slot for distillation columns and 75 percent of this velocity for absorbers, following the usual design practice.[2] To account for decreased space due to the liquid on the tray, the allowable velocity is reduced as liquid flow increases, as suggested by Carey.[2] Although these limits are arbitrarily chosen, they have been checked by operation of hydrocarbon fractionating and absorption columns. All columns designed on this basis operate satisfactorily, even though the tray diameters are smaller than those determined by other methods. Only in a few cases were these limits exceeded in actual operation.

Tray spacing will affect the column capacity because together with slot velocity it determines entrainment and allowable downspout build-up. The tray spacing used in these correlations is 24 inches, which is most frequently used in commercial petroleum installations.

Charts and Design Method—The information pertaining to design of a bubble tray can be conveniently presented as plots, examples of which are presented in Figures 1 to 9. The coordinates are the vapor rate expressed as pounds of vapor per cap per hour divided by a function of vapor and liquid density, and the liquid rate expressed as gallons per minute per foot of weir. The vapor rate function is derived from the pressure drop correlation by substituting for the slot velocity the more convenient pounds of vapor per cap per hour.

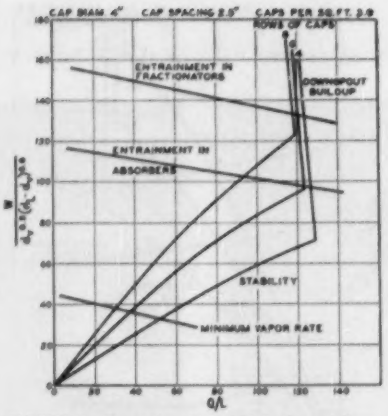


FIGURE 6—Operating limits (4-inch cap diameter, 2.5-inch cap spacing, 3.9 caps per square foot).

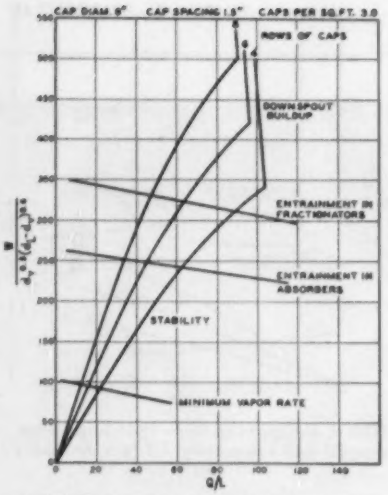


FIGURE 7—Operating limits (6-inch cap diameter, 1.5-inch cap spacing, 3.0 caps per square foot).

The area bounded by the entrainment limit at the top, downspout build-up, and stability on the right and minimum velocity at the bottom represents a region of satisfactory operation of bubble cap tray of the specified design. The design procedure based on these charts is as follows:

The vapor and liquid traffic are determined by heat and material balances around the column. Using the flow rates and physical properties of the materials, the minimum number of caps is calculated from the entrainment limit, and the minimum weir length is determined from the downspout capacity for each of the several cap spacings. Assigning a reasonable value to the overflow weir, expressed as a fraction of the column diameter, the column diameter required by liquid flow is determined. The column diameter required by the vapor is determined by assuming that the column area available for the caps is 80 percent of the total area left between the weirs. An actual tray layout is necessary to check the tray design if the area required by the caps is nearly equal to the available tray area after allowance has been made for downspouts. By this method, the minimum tray design is obtained. However, this is not the only satisfactory design. The tray can be made considerably larger and still operate satisfactorily. Thus, there is another approach to design of columns by means of these charts. A column size may be determined by other methods, such as the one by Souders and Brown,[21] and the design tested for operability by these charts. If the tray falls outside of one of the limits, changes must be made to bring it into the operable region. In this same manner, existing trays may be modified for new operating conditions.

Charts showing the region of operability are presented for 3, 4, and 6-inch caps and for 1.5, 2, and 2.5-inch spacing between caps. This allows wider selection of tray design than is commonly used in practice. In order to reduce the inventory requirements, most companies employ only one type of bubble cap; but because of the flexibility in arrangement of round caps, it is possible to get a suitable tray for nearly all conditions with one type of cap. In some cases, however, a spacing other than those shown here may give the optimum design.

Another simplification has been introduced by considering only the rectangular area of the tray behind the weir in the hydraulic gradient calculations. The omission of the additional tray area bounded by the column walls introduces a factor of safety by providing an additional flow area and thus reducing the hydraulic gradient below the value used to establish the limit of stability.

Two entrainment limits are shown, one for distillation columns and the other for absorbers, the latter corresponding to 75 percent of the allowable vapor rate for distillation columns. A single line is shown for each limit based on the value of (d_L-

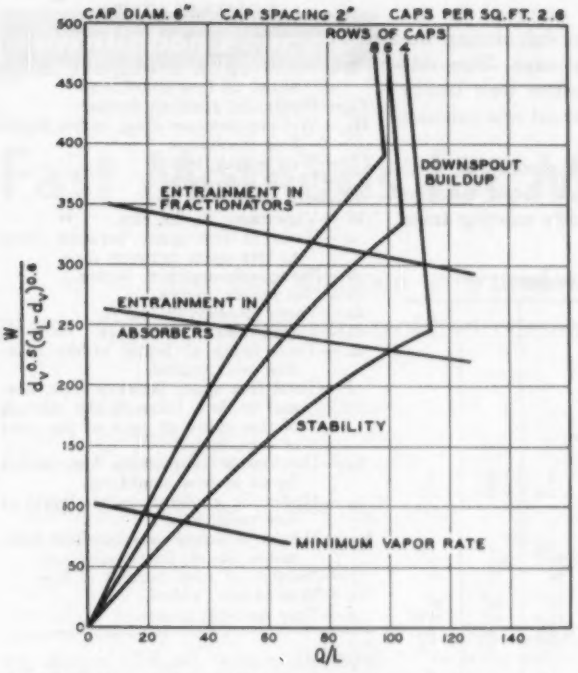


FIGURE 8—Operating limits (6-inch cap diameter, 2-inch cap spacing, 2.6 caps per square foot).

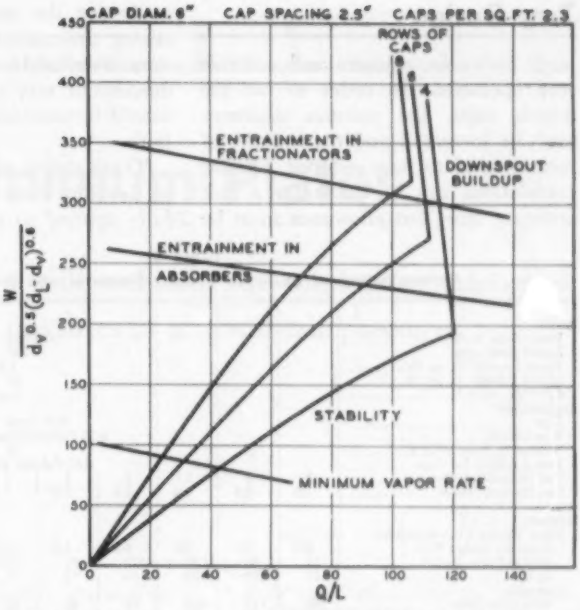


FIGURE 9—Operating limits (6-inch cap diameter, 2.5-inch cap spacing, 2.3 caps per square foot).

d_v) = 40. This gives a maximum variation of 3 percent for values of (d_L-d_v) between 30 and 60.

The use of these charts is limited to the specific tray patterns described, but the charts can be readily prepared for any tray layout. The ease of application and the completeness of answers obtained from these charts justify the time and effort expended in their construction for those engaged in designing commercial units.

It should be noted that, because of the assumptions made in the construction, these charts will apply more closely to large trays where the overflow weir equals or exceeds 75 percent of column diameter. For columns less than 5 feet in diameter and for trays with weir length less than 75 percent of column diameter, these charts will give conservative answers for stability. If, in checking the performance of an existing column the tray appears unstable on the charts, the hydraulic gradient should be calculated by the equations of Davies[9] and compared with the wet cap pressure drop. In many cases, this detailed calculation will show the tray layout to be satisfactory.

Several points are brought out by comparison of the charts.

(1) The effect of increased cap spacing on reducing the liquid gradient is much greater than that of eliminating some of the rows of caps normal to flow. Increasing the cap spacing to improve tray stability is preferable to reducing the number of rows of caps because it generally provides more caps on the tray, thus incorporating a higher vapor handling capacity, smaller pressure drop, and a more balanced tray.

(2) Downspout capacity limits only at high vapor and liquid rates and becomes more important when caps have wider spacing. Downspout capacity may be increased by increasing weir length, or by increasing the height of the inlet weir above the tray.

(3) When stability is limiting, greater liquid depth gives a more stable tray except for high vapor rates. The increase in stability is due to the decrease in liquid gradient as the main flow takes place further above the obstructions.

(4) At narrow cap spacing, the region of satisfactory operation is decreased. Trays with large bubble caps placed close together are less flexible than trays with wider spacing.

(5) The number of rows of caps normal to flow should be kept low to avoid uneven vapor distribution. Several methods are available to keep the hydraulic gradient low on large trays. Cascading the tray, installing risers of varying height, placing the caps near the overflow weir further apart, installation of intermediate weirs, and the use of multiple pass flow all serve to lower the gradient.

(6) The tray stability may also be increased by increasing the skirt clearance to reduce the liquid gradient or by modifying the bubble caps to increase the pressure drop at zero seal.

(7) Large caps have more vapor carrying capacity and should be used for high vapor loads. Small caps provide better tray layouts at high liquid loads.

Application of Charts—Charts of this type have been used for design of distillation columns and absorbers for several years. To date, all columns designed on this basis have operated satisfactorily.

A summary of design calculations for an absorber is shown in Table 2. Of the nine tray layouts available, two provide a definitely smaller column. The tray layout with 4-inch diameter caps, 2.5 inches apart, is best suited for the service if a full cross-flow tray is to be used. The tray layout with 3-inch caps, 2.5 inches apart, distributes the caps more evenly over the tray, except that more than eight rows of caps are required. This results in a

Distillation Pointers

Tray Design . . .

large hydraulic gradient and unstable tray operation. In order to use the 3-inch caps, the column diameter must be increased and the number of rows normal to flow reduced. Similar calculations can be made for a half crossflow tray, but allowance must be made for the area occupied by the center downspout in calculating the area available for caps. The side downspout tray overflow weir length should be used for liquid rate calculations.

These charts and the methods used to develop them have been successfully applied to modify existing trays and improve their performance. The calculations required to modify an existing tray are summarized in Table 3. Trial and error solution is necessary. In this case, the existing tray has too many caps, resulting in too low a vapor velocity. Reducing the number of caps by seven and the number of rows of caps by one increases the slot velocity above the minimum value, but the tray is still unstable. By further reduction of seven caps and one row, the vapor rate per cap is increased, and the number of caps decreased sufficiently to provide for satisfactory tray operation.

The results of modification of a hydrogen sulfide stripper are shown in Table 4. Another modification of an existing absorber, shown in Table 5, permitted a sponge oil rate increase from 4100 to 6100 barrels per operating day, which in turn increased propane absorption by 100 barrels per operating day. To accomplish this, 17 out of 46 caps were removed which resulted in stable tray operation and higher absorption efficiency.

Original presentation was at the national meeting of the American Institute of Chemical Engineers, St. Louis, December 12-15, 1954.

TABLE 2
Determination of Absorber Column Diameter and Tray Layout

Basis:									
Vapor Rate, lb./hr.					100,000				
Liquid Rate, gpm					500				
Vapor Density, lb./cu. ft.					1.0				
Liquid Density, lb./cu. ft.					63				
$d_v^{0.5}(d_L-d_v)^{0.5}$					11.9				
Assumptions:									
Flow					Full Cross				
Weir Length					0.75 Column Diameter				
Number of Rows of Caps					6				
Area Available for Caps					0.62 Column Area				
Cap Diameter, Inches	3	3	3	4	4	4	6	6	6
Cap Spacing, Inches	1.5	2.0	2.5	1.5	2.0	2.5	1.5	2.0	2.5
Solution:									
Using Figures 1 to 9 to obtain:									
Caps per Square Foot	8.2	6.7	5.5	5.2	4.6	3.9	3.0	2.6	2.3
$W/d_v^{0.5}(d_L-d_v)^{0.5}$	61	59	57	111	106	103	252	246	240
Q/L	56	81	105	45	74	94	34	52	70
Calculate:									
Minimum Caps	136	142	148	76	80	82	34	34	35
Area Required by Caps, sq.ft.	16.5	21.3	26.9	13.8	17.4	21.0	11.3	13.1	15.2
Col. Diam. Based on Caps, ft.	5.9	6.6	7.4	5.4	6.0	6.6	4.8	5.2	5.6
Required Weir Length, ft.	8.9	9.2	4.8	11.1	6.8	5.3	14.7	9.6	7.1
Col. Diam. Based on Weir Length, ft.	....	....	6.3	....	....	7.0	....	....	....
Rows of Caps for Full Cross Flow	....	....	Over 6	....	....	Below 6	....	....	....

TABLE 3
Modification of Existing Tray

Basis:			
Tray Diameter, ft.			5.5
Cap Diameter, inches			4.0
Number of Caps			42
Cap Spacing, inches			2.5
Number of Rows			6
Weir Length, ft.			4.1
Vapor Rate, lb./hr.			15,000
Liquid Rate, gpm			200
Vapor Density, lb./cu. ft.			1.2
Liquid Density, lb./cu. ft.			53
Solution—See Figure 6			
	Trial 1	Trial 2	Trial 3
Number of Caps	42	35	28
Number of Rows	6	5	4
W			
$d_v^{0.5}(d_L-d_v)^{0.5}$	20.8	25.8	44.7
Q/L			
Remarks	48.8 Vapor Rate Too Low	48.8 Tray Unstable	48.8 Satisfactory Modification

TABLE 4
Modification of Hydrogen Sulfide Stripper Trays

Design Basis:		
Vapor Rate, lb./hr.		25,300
Vapor Density, lb./cu. ft.		0.171
Liquid Rate, lb./hr.		802,500
Liquid Rate, gpm		1,730
Liquid Density, lb./cu. ft.		80.0
Cap Diameter, inches		4
Cap Layout		Triangular
	Original	**Modified**
Tray Layout:		
Diameter, ft.	12.5	12.5
Number of Caps	486	258
Rows of Caps	10	4 Between Intermediate Weirs
Distance Between Caps, ins. W	1.25	2
$d_v^{0.5}(d_L-d_v)^{0.5}$	29	55
Q/L (Half Cross-flow)	69	69
Remarks	Unstable—Vapor velocity too low H_2S stripping not complete	H_2S stripping satisfactory at 150% of design capacity

TABLE 5
Absorber Tray Modification

	Original	**Modified**
Vapor Rate, lb./hr.	18,875	18,875
Vapor Density, lb./cu. ft.	0.855	0.855
Liquid Rate, gpm	123	180
Liquid Density, lb./cu. ft.	48.8	48.8
Cap Diameter, inches	4	4
Distance between Caps, inches	1.25	1.25
Cap Layout	Triangular	Triangular
Tray Diameter, ft.	4	4
Number of Caps	46	29
Number of Rows of Caps	7	4
W	43.5	69
$d_v^{0.5}(d_L-d_v)^{0.5}$		
Q/L	31	45
Propane Recovery Increase, barrels per operating day	....	100

NOMENCLATURE

- A_d —Smallest flow area in downspout, sq. ft./tray.
- B —Build-up in downspout, inches liquid at flow conditions.
- C_d —Hydraulic gradient factor.
- H_c —Wet cap pressure drop, inches liquid flow conditions.
- L —Weir length, feet.
- Q —Liquid rate, gpm.
- U —Slot velocity, ft./sec.
- W —Vapor rate, lb./hr. cap.
- a —Ratio of free space between risers to free space between caps.
- b —Static submergence, inches.
- d_s —Slot height, inches.
- d_v —Vapor density, lb./cu. ft.
- d_L —Liquid density, lb./cu. ft.
- d_o —Total depth of liquid at the overflow weir, inches.
- f —Total free space between caps, normal to flow, taken as the average of free space at each of the rows of caps, inches.
- h_D —Downspout contraction loss, inches liquid at flow conditions.
- h_g —Hydraulic gradient, inches liquid at flow conditions.
- h_w —Height of liquid over overflow weir, inches liquid, flow conditions.
- r —Number of rows normal to flow.
- s —Skirt height, inches.
- t —Tray spacing, inches.

ACKNOWLEDGEMENT

The author wishes to express his sincere appreciation to Dr. D. N. Hanson of the Chemical Engineering Department of the University of California for his assistance during the initial phases of this work which were completed as partial requirements for a Master of Science Degree.

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Fast Methods for Minimum Plates

The new diagram presented here will estimate the minimum number of plates required for separation of hydrocarbon mixtures at atmospheric pressures.

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HERE'S A WAY to simplify the calculations involved in the design of fractionating equipment. The chart which has been derived, permits an estimation to be made of the minimum number of plates required for the separation of a complex hydrocarbon mixture at atmospheric pressure.

The Relation Between the Distillate and Bottoms Composition—

Fenske's[2] equation for the minimum number of plates may be written:

Meet the Author

R. M. BUTLER, assistant professor of chemical engineering at Queens University in Kingston, Ont., spends his summers in research for Imperial Oil Company, Ltd., at Sarnia. Of special interest to Dr. Butler are distillation and other separation processes, applied mathematics, automatic control systems and thermodynamics. A native of London, he was educated at the Imperial College of Science and Technology where he received a doctor's degree in chemical engineering. He is a member of the Professional Engineers of Ontario and Chemical Institute of Canada, as well as an associate of AIChE and a graduate of the Institute of Chemical Engineers.

Where

$$\frac{N_{1D}}{N_{2D}} = \alpha^{n}_{1\text{-}2}\,\frac{N_{1W}}{N_{2W}} \qquad (1)$$

$\alpha_{1\text{-}2}$ is the relative volatility of 1 with respect to 2.

N_{1D} is the quantity of 1 in the distillate
N_{2D} is the quantity of 2 in the distillate
N_{1W} is the quantity of 1 in the bottoms
N_{2W} is the quantity of 2 in the bottoms
n is the total number of theoretical plates

It should be noted that N may be measured in any convenient units, e.g. moles, gms., pounds, gallons, barrels, etc. It is only necessary that the same units be used to describe both the bottoms and the distillate.

A considerable simplification is made if all of the relative volatilities are measured with respect to the component which is equally distributed between the distillate and bottoms.

i.e. if $N_{2D} = N_{2W}$ then (1) becomes,

$$N_{1D} = \alpha^{n}_{1}\,N_{1W} \qquad (2)$$

since $N_{1D} + N_{1W} = N_{1F}$ (3)
where N_{1F} is the quantity of 1 in the feed, then,
Fraction of 1 in feed in bottoms =

$$\frac{N_{1W}}{N_{1D} + N_{1W}} = \frac{1}{1 + \alpha^{n}_{1}} \qquad (4)$$

A similar relation may be written for each component. The upper part of Figure 1 is a plot of Equation (4). It should be noted that the sharpness of the separation increases with the number of theoretical plates.

The Relation between the Boiling Point and Relative Volatility of Hydrocarbons—

Equation (7) may be obtained by combining the Clausius-Clapeyron Equation (5) with Trouton's rule[3] (6).

$$P = Ae^{\frac{-L}{RT}} \qquad (5)$$

$$\frac{L}{T_B} = 21 \text{ Btu/lb. mole } ^\circ\text{R} \qquad (6)$$

$$\log_{10} P = 4.60\left(1 - \frac{T_B}{T}\right) \qquad (7)$$

When

P is the vapor pressure of the hydrocarbon in atmospheres
T is the absolute temperature in °R
T_B is the normal boiling point in °R
L is the latent heat of evaporation
A is a constant for any particular material

Equation (7) provides a means of predicting the vapor pressure of a hydrocarbon as a function of temperature. It has recently been shown that this equation represents the vapor pressure data for a number of hydrocarbons over the range 0.1 to 10 atmospheres.[1]

Since hydrocarbon solutions are approximately ideal the relative volatility of one component with respect to another at low pressures is given by the ratio of their vapor pressures.

Hence:

$$\log \alpha_1 = 4.60\left(1 - \frac{T_{B1}}{T}\right) - 4.60\left(1 - \frac{T_e}{T}\right) \qquad (8)$$

Where

T_{B1} is the boiling point of component 1 and
T_e is the boiling point of the equally distributed component

Since the average temperature in the distillation column will be approximately equal to T_e, Equation (8) may be simplified by letting T equal T_e. If this is done, the following approximate equation for the average value of log α_1 is obtained,

$$\log \alpha_1 = 4.60\left(1 - \frac{T_{B1}}{T_e}\right) \qquad (9)$$

Equation (9) has been plotted in the lower part of Figure 1. The relative volatility scale is the same as in the upper part and the cut point temperature scale is proportional to the reciprocal of T_e. The family of convergent straight lines represent the

relative volatilities of hydrocarbons of various boiling points with respect to a hydrocarbon boiling at the cut point temperature. These lines may be used to convert the logarithmic relative volatility scale into a linear boiling point scale for any particular cut point.

Practical Example—What is the minimum number of theoretical plates required to separate a complex hydrocarbon mixture so that the distillate contains nothing boiling above 400 F. and the bottoms contains nothing boiling below 300 F?

Although this is the manner in which a practical question might be worded, it should be appreciated that it is really impossible to completely eliminate materials from the products of a finite distillation column.

In order to answer the question, we have to decide first what quantity of contaminants is sufficiently small to be considered as zero.

Let us consider that the following reworded question will be satisfactory:

"What is the minimum number of theoretical plates required to separate a complex hydrocarbon mixture so that the distillate contains only 0.5 percent of the material in the feed having a boiling point of 400 F. and the bottoms contains only 0.5 percent of the material in the feed boiling at 300 F?"

Solution—Cut Point Temperature $= \frac{400 + 300}{2} = 350$ F.

For this cut point the following relative volatilities are found from the lower part of Figure 1.

300 F. B.Pt. material $\alpha = 1.9$
400 F. B.Pt. material $\alpha = 0.52$

From the upper part of Figure 1 it is found that about 8 theoretical plates are required. About twice this number of plates will be needed at a practical reflux ratio.

If the true boiling point curve of the feed is known, the corresponding curves for the distillate and bottoms may be drawn by multiplying the quantities in the feed by the factors found from the upper part of Figure 1.

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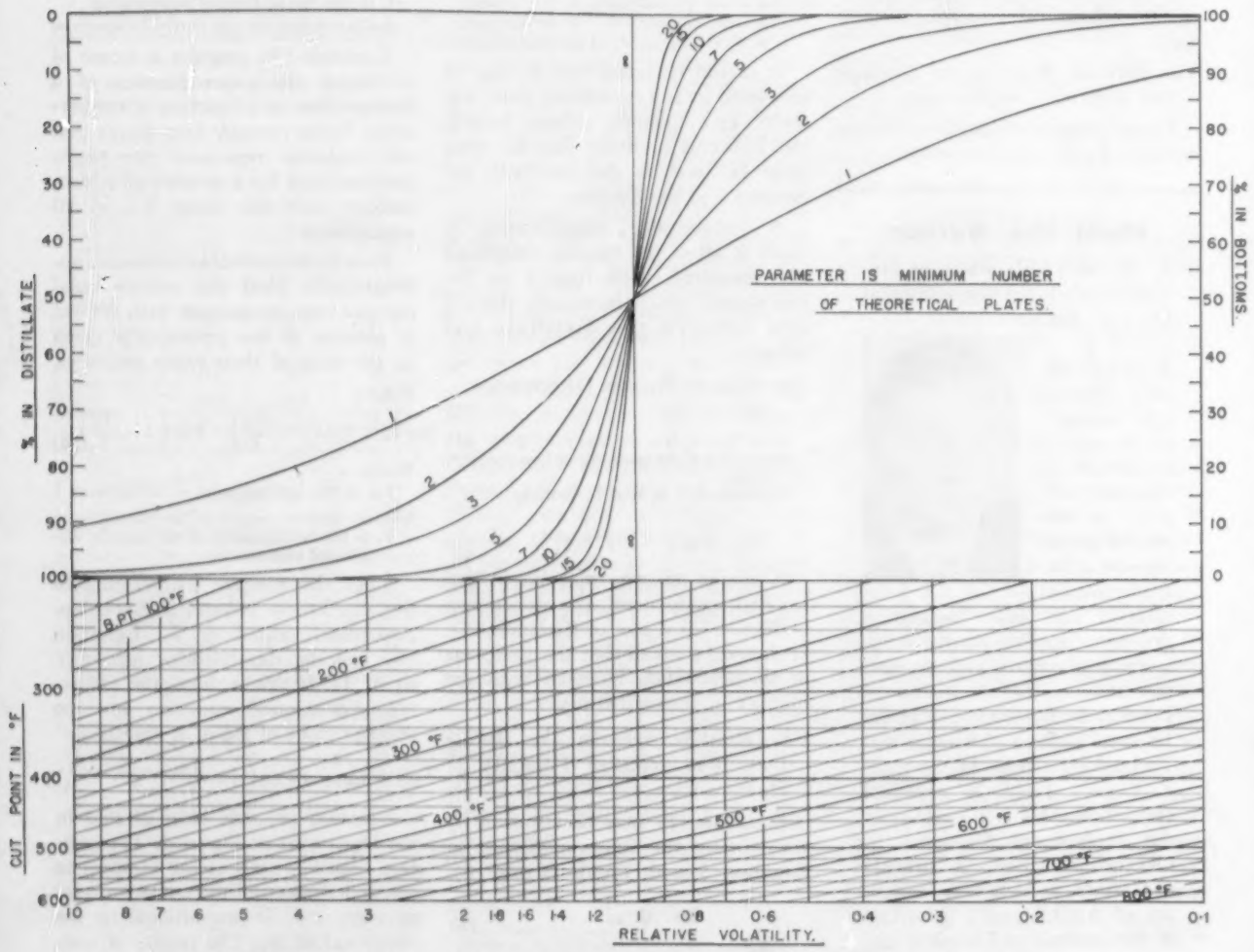

FIGURE 1—Use this chart to determine the minimum number of theoretical plates for hydrocarbon separations.

Use these NOMOGRAPHS for . . .

Slot Openings in Bubble Caps

No more tedious calculations with these nomographs in your working book. Make rapid and direct solutions with this method.

Francis W. Winn and George J. Keller,
Fractionation Research, Inc.,
Alhambra, California

SLOT OPENING is used for correlating and predicting pressure drop, entrainment, capacity and efficiency of bubble cap columns. Equation (1), below gives slot opening for triangular, trapezoidal and rectangular slots as a function of dimensions of the slot, vapor rate, and density of the liquid and vapor.

This equation may be derived in a manner similar to that used by Rogers and Thiele[5] and is equivalent to that given by Simkin, et al.[6] It reduces to the equations of Rogers and Thiele[5] for rectangular or triangular slots.

For rectangular slots see Equation (2), below.

For triangular slots see Equation (3), below.

These equations can be solved directly for slot opening in the case of triangular or rectangular slots. Equation (1) must be solved by successive trials for trapezoidal slots.

Direct and rapid solutions can be obtained for all three cases by use of nomograms or by a series of coordinate plots. Figure 1 is a nomographic solution of Equation (1) for low values of $(Q_s h_s/W_2)\left(\frac{\rho_V}{\rho_L - \rho_V}\right)^{1/2}$ and Figure 2 applies to high values. The value of the orifice coefficient

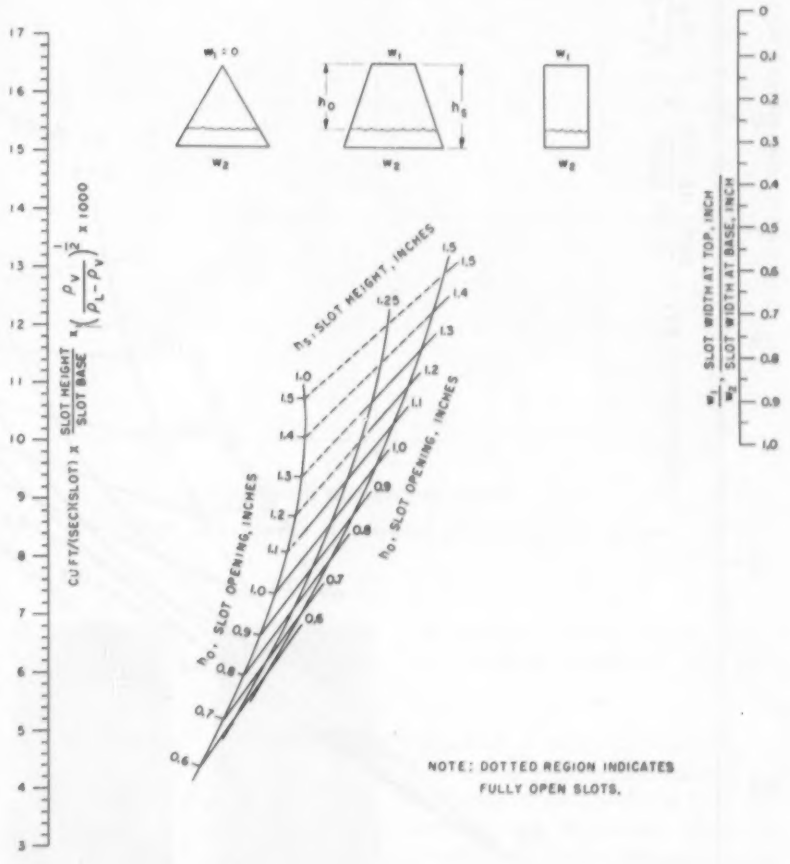
CU FT/SEC/SLOT) x SLOT HEIGHT / SLOT BASE x ((ρV/(ρL−ρV))^1/2 x 1000
hs, SLOT HEIGHT, INCHES
ho, SLOT OPENING, INCHES
w1, SLOT WIDTH AT TOP, INCH
w2, SLOT WIDTH AT BASE, INCH
NOTE: DOTTED REGION INDICATES FULLY OPEN SLOTS.

FIGURE 2—Slot opening high range. See FIGURE 1, Next Page.

$$\left(\frac{Q_s h_s}{W_s}\right)\left(\frac{\rho_V}{\rho_L - \rho_V}\right)^{1/2} = \frac{c(2g)^{1/2}}{(12)^{5/2}}\left[\frac{4h_o^{5/2}}{15} + \left(\frac{W_1}{W_2}\right)\left(\frac{2h_s(h_o)^{3/2}}{3} - \frac{4(h_o)^{5/2}}{15}\right)\right] \quad (1)$$

$$(h_o)^{5/2} = (12)^{5/2}\left(\frac{3}{2}\right)\left(\frac{Q_s}{cW_s}\right)\left(\frac{\rho_V}{\rho_L - \rho_V}\right)^{1/2}\left(\frac{1}{2g}\right)^{1/2} \quad (2)$$

$$(h_o)^{5/2} = (12)^{5/2}\left(\frac{15}{4}\right)\left(\frac{Q_s h_s}{cW_s}\right)\left(\frac{\rho_V}{\rho_L - \rho_V}\right)^{1/2}\left(\frac{1}{2g}\right)^{1/2} \quad (3)$$

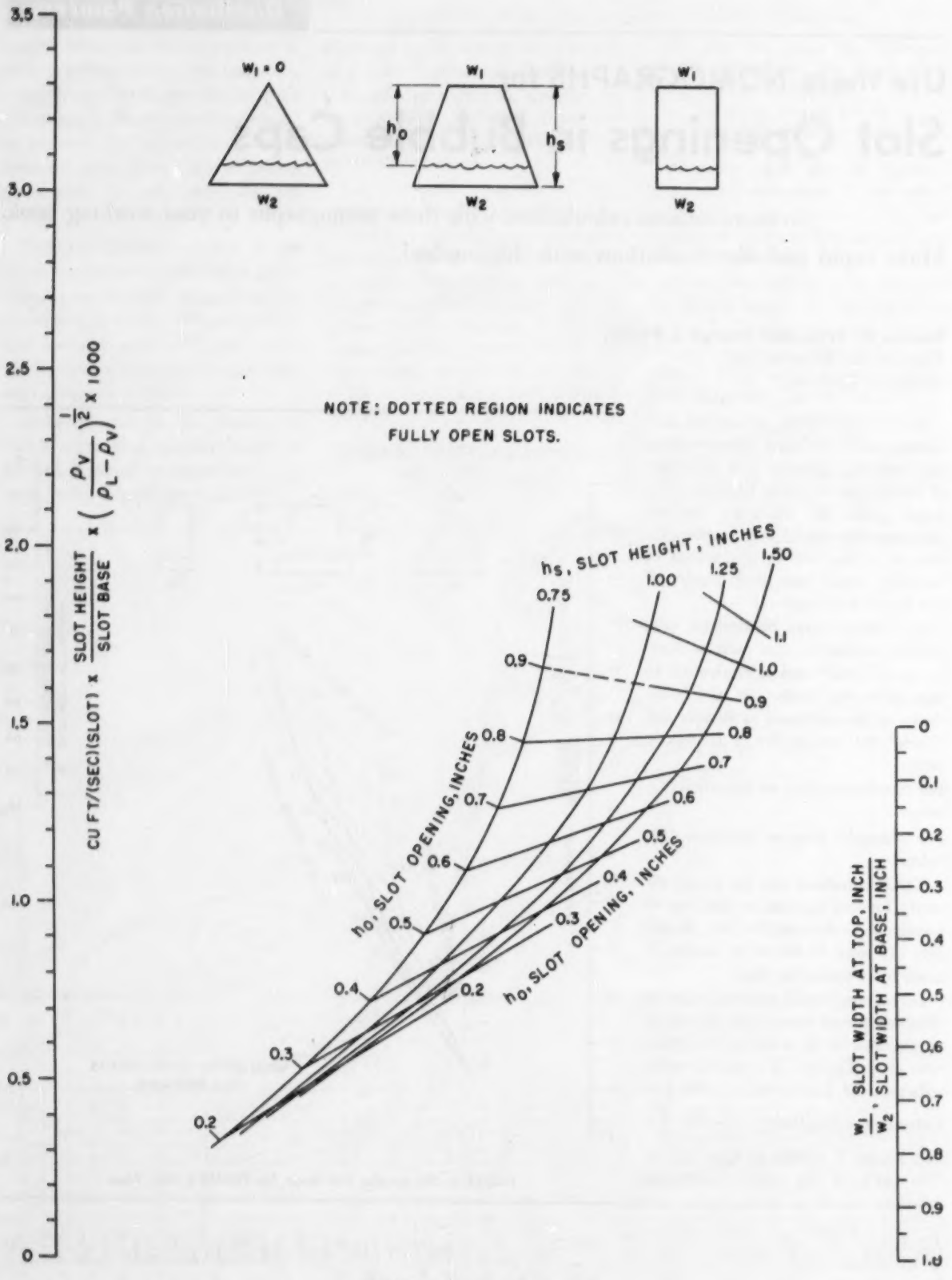

FIGURE 1—Slot opening low range.

NOMENCLATURE

c = orifice coefficient
Q_s = vapor rate, cfs/slot
h_o = slot opening, inch
h_s = slot height, inch
ρ_L = liquid density, lb./cu. ft.
ρ_V = vapor density, lb./cu. ft.
W_1 = slot width at top, inch
W_2 = slot width at base, inch
g = gravitational constant, 32.2 ft./(sec.)^2

used to construct the nomograms was 0.57. This value was chosen to correlate published data with a minimum average deviation. A comparison of experimental (1, 3, 4, 5, 7, 8) and correlated values of slot opening is shown on Figure 3. The average deviation is about $\pm$ 0.05 inch.

Data of Cross and Ryder[2] on a rectangular slot 8 inches high by 2 inches wide and a triangular slot 8 inches high with a 5-inch base also show good agreement with the same equations using an orifice coefficient of 0.57.

It should be noted that these equations do not apply for slot openings below the point of incipient bubbling or beyond the point of fully opened slots. A discussion of slot opening at incipient bubbling is contained in the article by Huitt, et al.[4]

ACKNOWLEDGMENT

Permission of Fractionation Research, Inc., to publish this paper is acknowledged.

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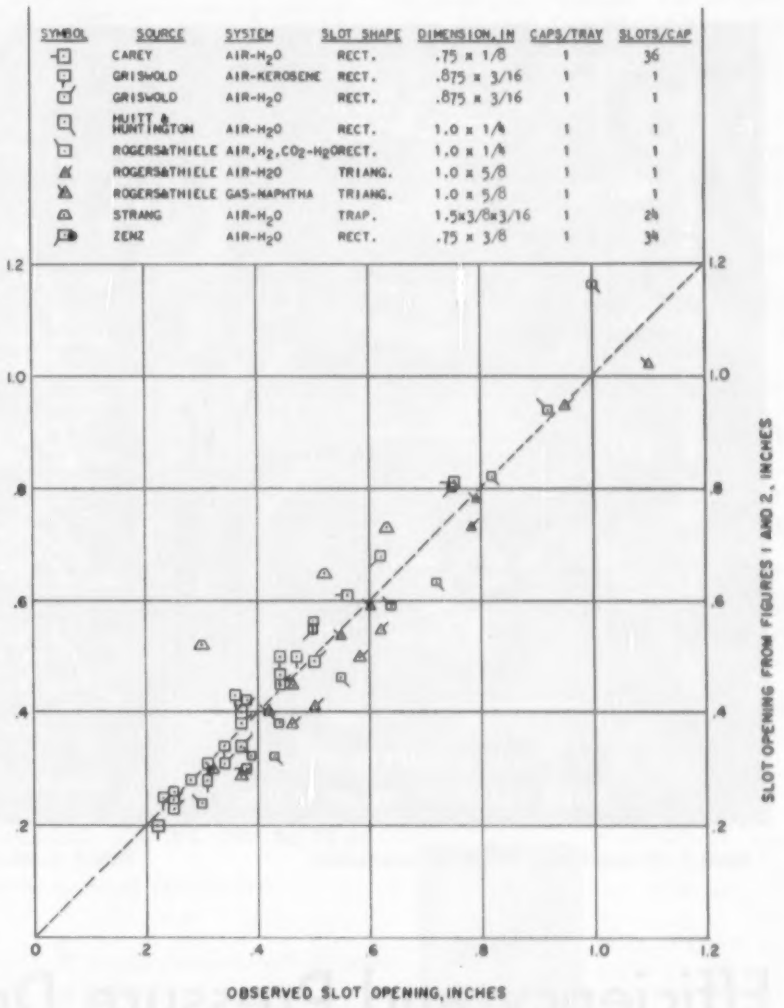
SYMBOL | SOURCE | SYSTEM | SLOT SHAPE | DIMENSION, IN | CAPS/TRAY | SLOTS/CAP
CAREY | AIR-H2O | RECT. | .75 x 1/8 | 1 | 36
GRISWOLD | AIR-KEROSENE | RECT. | .875 x 3/16 | 1 | 1
GRISWOLD | AIR-H2O | RECT. | .875 x 3/16 | 1 | 1
HUITT & HUNTINGTON | AIR-H2O | RECT. | 1.0 x 1/4 | 1 | 1
ROGERS&THIELE | AIR,H2,CO2-H2O | RECT. | 1.0 x 1/4 | 1 | 1
ROGERS&THIELE | AIR-H2O | TRIANG. | 1.0 x 5/8 | 1 | 1
ROGERS&THIELE | GAS-NAPHTHA | TRIANG. | 1.0 x 5/8 | 1 | 1
STRANG | AIR-H2O | TRAP. | 1.5x3/8x3/16 | 1 | 24
ZENZ | AIR-H2O | RECT. | .75 x 3/8 | 1 | 34
0
.2
.4
.6
.8
1.0
1.2
OBSERVED SLOT OPENING, INCHES
SLOT OPENING FROM FIGURES 1 AND 2, INCHES

FIGURE 3—Comparison of calculated and observed slot openings.

Meet the Authors

FRANCIS W. WINN is technical director for Fractionation Research, Inc. A chemical engineering graduate from the University of Oklahoma, he joined the research company in 1953, following an assignment as assistant chief engineer with Catalytic Construction Corporation. He also was associated with Pan American Petroleum Corporation, Socony-Vacuum Oil Company and at one time, served the Petroleum Administration for War. A previous contributor to the Petroleum REFINER, Winn's article entitled, "Equilibrium K's by Nomography," was published in issue for June 1954.

Keller

Winn

•

GEORGE J. KELLER was engaged in chemical engineering research and development work with the U. S. Department of Agriculture when he joined Fractionation Research in 1954. He received his chemical engineering degree from the University of California. Keller is author of several technical articles contributed to various journals.

Distillation Pointers

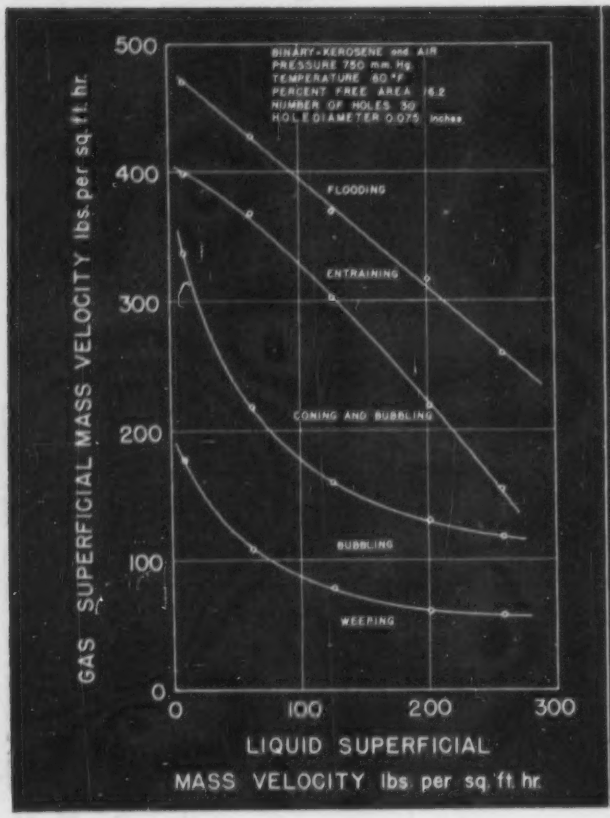

Figure 1—Perforated plate operational characteristics.

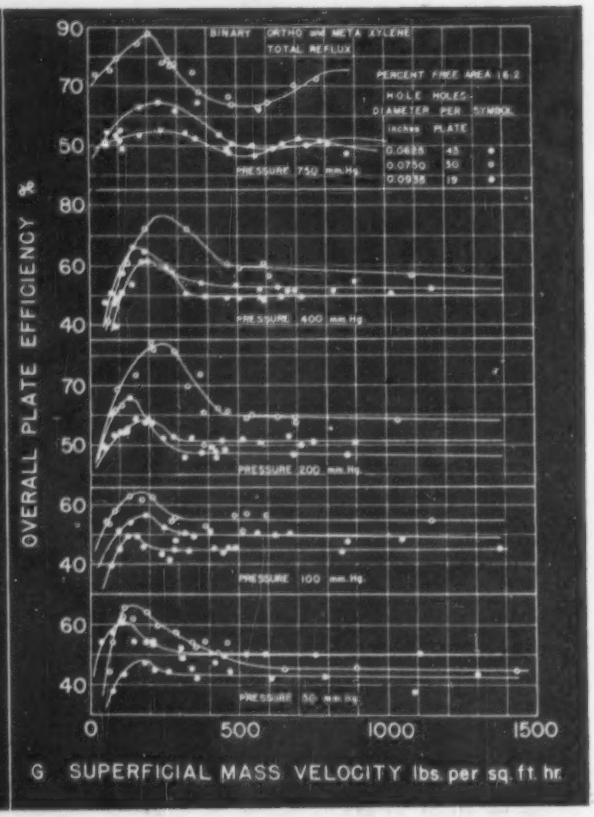

FIGURE 2—Effect of hole diameter on over-all plate efficiency.

Efficiency and Pressure Drop for Perforated Plates

Here are new experimental data on a small diameter column.

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University of Texas,
Austin

PERFORATED PLATE fractionating columns have been used as distillation and fractionating devices for some time. Only recently, however, have been made systematic studies of their operating characteristics and the variables affecting them.

In this investigation a study was conducted on a 1.02-inch diameter column to determine the operating limits, over-all plate efficiency and pressure drop as a function of vapor rate, pressure, perforated plate hole diameter, and system characteristics. The fractional free area (sum of hole areas divided by the superficial free column area) was maintained at 0.162, the plate spacing was 2 inches,

* Mr. Umholtz' present address is Humble Oil & Refining Company, Technical Service Division, Baytown, Texas.

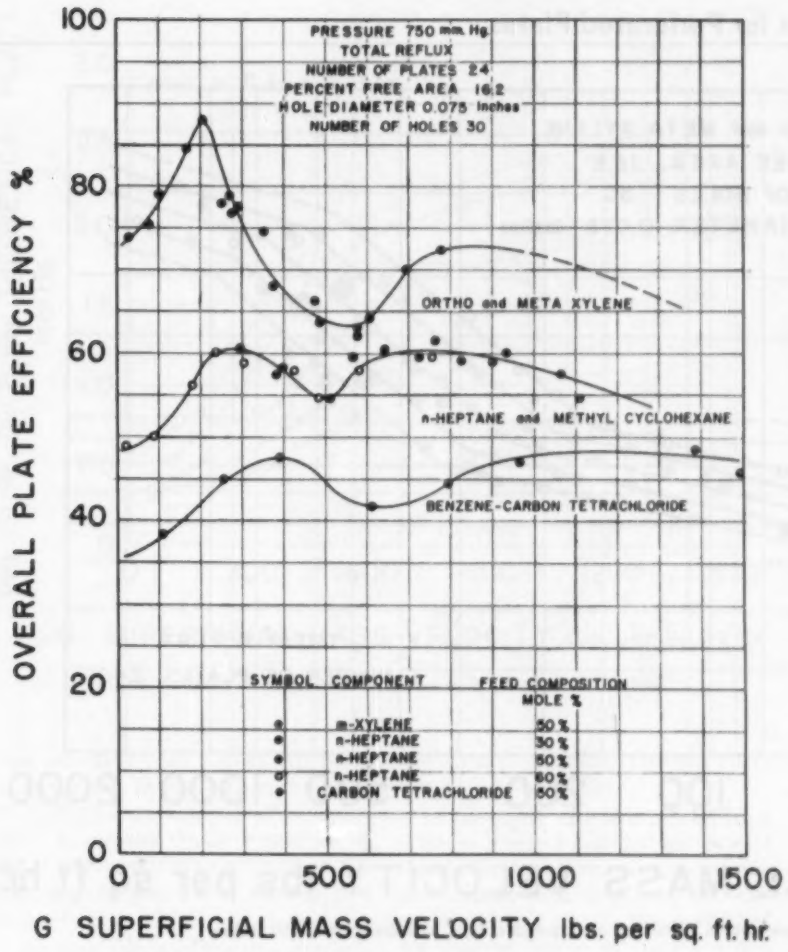

FIGURE 3—Effect of system properties on over-all plate efficiency.

and the weir height 0.0625 inches. Five plates were used in the hydraulic test column to determine operational characteristics and 24 plates were used in the efficiency tests. The efficiency tests were run at total reflux so that the liquid and vapor rates were the same.

Air, kerosine, water, 10 percent ethanol-water, and m-xylene were utilized for the operational tests. In the efficiency tests the following binaries were used: n-octane-tolune, n-heptane-methyl cyclohexane, benzene-carbon tetrachloride, and o- and m-Xylene.

As the result of the investigation it was found that:

(1) Efficiency increased and then decreased to essentially a constant value as vapor rate was increased.

(2) Efficiency was greater for the 0.075-inch hole diameter plates than for the others tested.

(3) Efficiency decreased with decrease in pressure.

(4) Pressure drop increased with increase in vapor rate.

(5) Pressure drop increased as hole diameter decreased.

(6) Pressure drop increased as the pressure decreased.

No quantitative conclusions could be made concerning the effect of system characteristics on efficiency and pressure drop.

When perforated plate fractionaters were first introduced it was concluded, apparently from insufficient test data, that their performance was seriously limited with respect to capacity. Recent reports of plant scale column performance[6] indicates capacity range for this type of tray to be comparable to that of bubble cap trays.

The present study was made to determine the effect of certain dimensional factors of design as well as thruput and pressure on operating limits; capacity, efficiency and pressure drop in a laboratory batch, perforated plate column. This column was designed as a true boiling point column, capable of operation at atmospheric as well as subatmospheric pressures.

Hydraulic Operational Characteristics—Preliminary to the efficiency studies a five-plate column in which hole diameter, fractional free area, liquid rate, gas rate, and liquid system were varied was used to indicate practical limits of operation with respect to hydraulic characteristics. Air was used as the gas.

The range of variables was as follows:

Hole diameter: 0.0625, 0.075, 0.089, 0.0935, 0.1250 and 0.1875 inches.
Fractional free area: 0.05 to 0.27
Liquid rate: 0 to 2000 pounds per square foot-hour.
Air rate: 0 to 1500 pounds per square foot-hour.
Liquids: water, kerosine, m-xylene, 10 percent ethanol.

On the hydraulic test equipment operational graphs were obtained for each hole diameter at a particular

Meet the Authors

C. L. UMHOLTZ met his co-author at the University of Texas where Mr. Van Winkle was one of his professors in chemical engineering. Dr. Umholtz entered the university shortly after World War II and completed his bachelor's, master's and doctor's degree there in chemical engineering. Now with Humble Oil & Refining Company, he is assigned to the Technical Service division at the Baytown, Texas, refinery. During the war, he flew 20 missions over Japan as a B-29 flight engineer.

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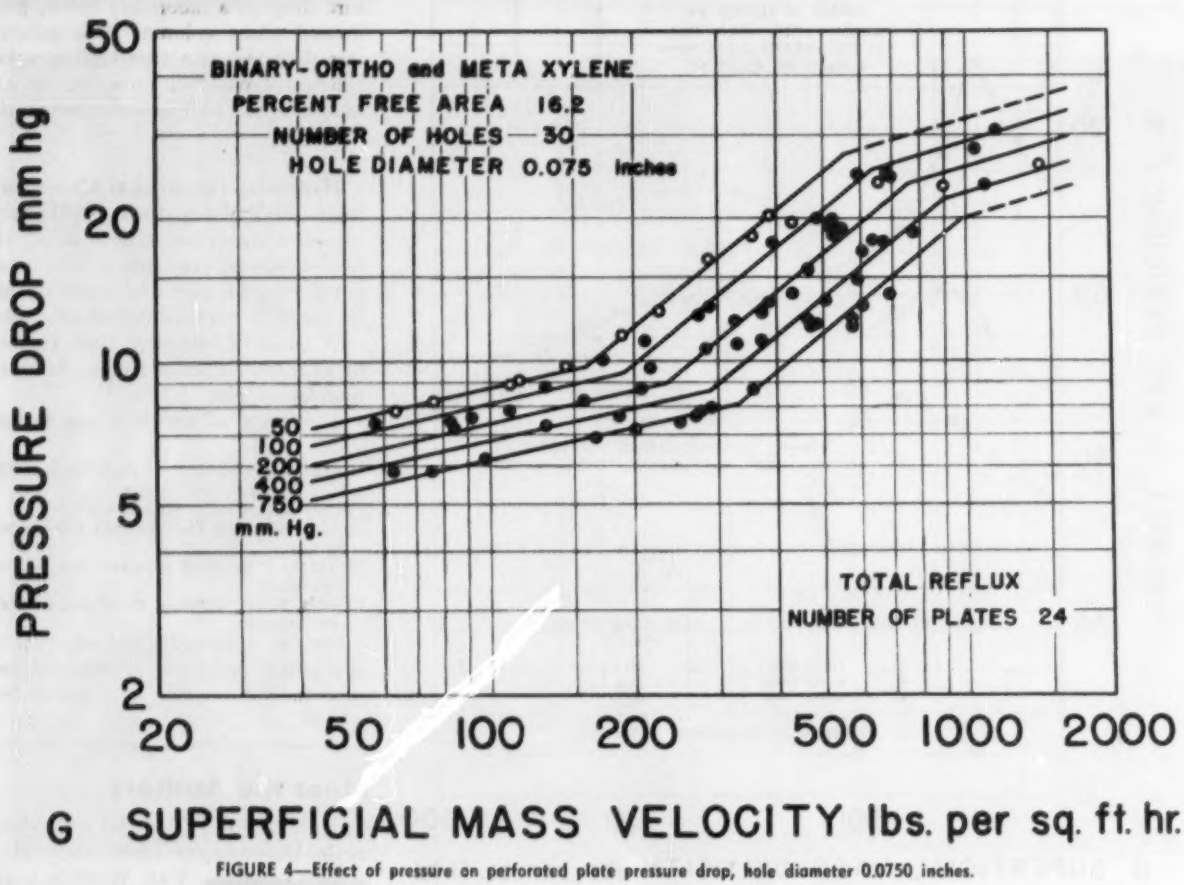

FIGURE 4—Effect of pressure on perforated plate pressure drop, hole diameter 0.0750 inches.

fractional free area. Figure 1 is the graph for the 0.075-inch diameter hole at 0.162 fractional free area using air and kerosine. The labeled areas correspond to observed operation.

Weeping: the liquid drained through the holes—no bubbling.

Bubbling: bubbling and weeping occurred.

Coning and bubbling: bubbling continued and a few holes showed coning.

Entraining: suspended droplets of liquid carried to the plate above.

Flooding: liquid backed up on the plate until the column flooded.

These observations were qualitative rather than quantitative. It was noted that at constant hole diameter a decrease in fractional free area resulted in a wider operating range (greater area between weeping and flooding curves). At a constant fractional free area the operating range increased as hole diameter decreased.

Plate Efficiency—Based upon the hydraulic tests a fractional free area of 0.162 and plates of three hole sizes, 0.0625, 0.075 and 0.0935 inches, were selected for efficiency studies. The o- and m-xylene system was used. The still containing 24 plates on 2-inch spacing with downcomers and having 0.0625-inch weir height, was designed for essentially adiabatic operation. Provision was made for operation under vacuum.

The still was operated at total reflux for a period of 60 minutes before samples were withdrawn from the bottom and the reflux line for analysis.

The number of theoretical plates needed to obtain the compositions thus determined were calculated from Fenske's equation:[5]

$$\left(\frac{x}{y}\right)_D = \left(\frac{y}{x}\right)_B \alpha^{n+1}$$

where y = mole fraction of the more volatile component
x = mole fraction of the less volatile component
D = overhead product
B = bottom product
α = relative volatility
n = minimum number of plates at total reflux

The reboiler was considered a theoretical plate and subtracted from n to determine the column theoretical plates. The efficiency was calculated by dividing the actual plates (24) into the theoretical number of plates. The relative volatility was calculated from vapor pressures of the components, obtained from,[6] at the arithmetic average temperature at the top and bottom of the column. The relative volatility for the benzene-CCl_4 system was obtained from the data of Langdon and Tobin.[4]

Effect of Pressure—Figure 2 indicates that as pressure decreases the plate efficiency decreases in all cases.

Effect of Hole Size—From Figure 2 it can be seen that the best efficiency obtained from the three types of plates tested is that using the 0.075 inch diameter holes.

Nandi and Karim[6] reported efficiency increased at constant fractional free area as hole diameter decreased.

Effect of Vapor Rate—In all cases the efficiency increased as the vapor

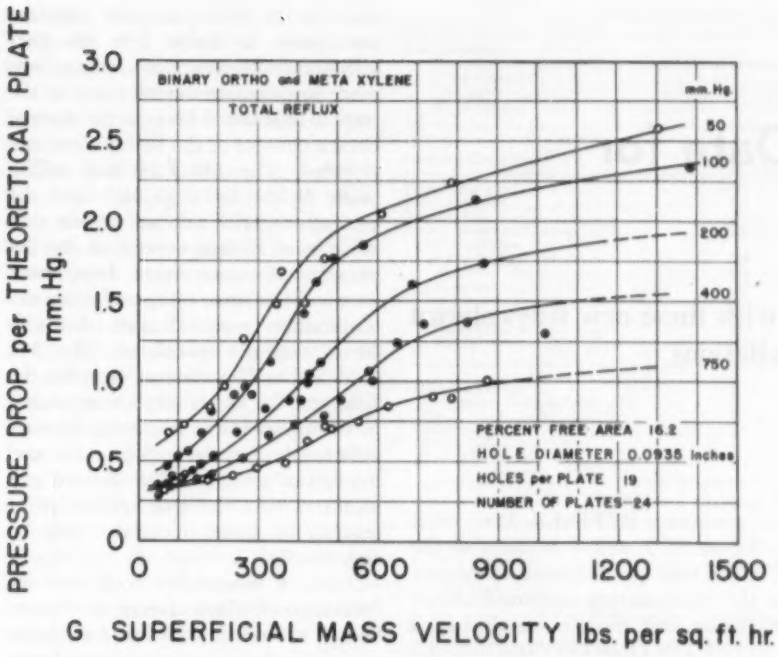

FIGURE 5—Effect of pressure on "pressure drop per theoretical plate."

rate increased until a peak efficiency was reached. Beyond this each of the efficiency curves dropped off to essentially a constant value regardless of the thruput with the exception of the 750 mm curves. These showed two peaks.

An explanation of the characteristic behavior of these curves can be made as follows. Mass transfer between the vapor and liquid phases can take place by virtue of a number of mechanisms: (1) transfer during bubble formation, (2) transfer during bubble rise through the liquid, (3) transfer in the foam layer, (4) transfer in the spray above the plate where the liquid is in the discontinuous phase and (5) transfer on the walls and inner surfaces of the column. These mechanisms are a function of the vapor velocity or thruput rate.

The amount of mass transfer is dependent upon the liquid and vapor phase resistances, the concentration driving forces and the contact area between the phases. For a narrow temperature range the efficiency of transfer is primarily dependent upon the contact area.

At the lower vapor velocities the bubble area controls and it is the result of the size and number of bubbles formed per unit time. This is a function of vapor velocity.[1]

As the vapor rate is increased from 0 the number of bubbles and rate of bubble formation increases, increasing the contact area and thus the efficiency. After a certain rate is reached the bubbles begin to coalesce and chain, effectively reducing the contact area and lowering the efficiency. This continues until the vapor velocity becomes great enough to break up the liquid into a spray and form foam so that the efficiency is again increased because of the greater area in the liquid phase. To counteract this, however entrainment takes place where liquid droplets are carried over to the plate above. Thus the efficiency curves tend to level out at a constant value.

Peavy and Baker[8] showed a two-peak efficiency on their curves. These are shown at 750 mm in the present work but are not evident at the lower pressures.

Effect of System—Three systems o—m-xylene, n-heptane-methylcyclohexane, and benzene-carbon tetrachloride were run in the column with the 0.075-inch holes and 0.162 fractional free area to determine system effects on efficiency. The o—m-xylene system gave the highest efficiencies and the benzene-carbon tetrachloride the lowest (Figure 3). All three systems showed characteristic curves of increasing—then decreasing efficiencies with thruput.

Attempts to correlate efficiencies of these systems with properties such as viscosity and volatility using Drickamer and Bradford[2] and O'Connell[7] correlations were not too successful. The experimental efficiencies were higher than those predicted by Bradford[2] and lower than those predicted by O'Connell.[7]

Pressure Drop—Figure 4 indicates the total pressure drop through the 24 plate column for various pressures using the 0.075-inch diameter holes and a fractional free area of 0.162 with varying vapor rate. It can be seen that pressure drop increases as the vapor rate increases and that it increases as the pressure decreases. Curves of the same type evaluated for the other size holes were of the same nature and it was found that for the same fractional free area the pressure drop increases as the hole diameter decreases. Also it was found that the pressure drop decreases as the fractional free area increases.

Pressure Drop Per Theoretical Plate—In distillation, particularly under vacuum conditions, pressure drop and plate efficiency are important design factors. Figure 5 indicates the variation of a combination of the two factors as "pressure drop per theoretical plate" at various pressures as a function of thruput. Since the plate efficiency drops as pressure is decreased and also the pressure drop increases as pressure decreases the pressure drop per theoretical plate becomes magnified.

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Distillation Pointers

New Operating Data for Uniflux Trays

Success of operation with these new trays shown by data from commercial installations.

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INDUSTRY acceptance, as measured by the number of successful applications, has been the experience of Uniflux trays. The record shows that these trays are being employed in a variety of applications, including crude distillation, alkylation, stabilization, absorption and stripping. It also shows that there are over 100 fractionating towers with these trays currently in operation and that approximately 150 additional towers are being engineered or constructed.

How well these trays perform is illustrated by data presented from commercial operating units. Details of tray design and construction were presented in PETROLEUM REFINER, May, 1954.

Tables 1, 2 and 3 summarize the Uniflux tray performance of certain of the fractionating equipment in an alkylation unit recently installed in a plant of The Ohio Oil Company. All of the towers in this unit employ Uniflux fractionating trays but operating data are available only on the three reported herewith. In all cases the data presented represents average results of a ten day acceptance test run. The deisobutanizer performance described in Table 1 indicates that this tower was doing the equivalent of 58 theoretical trays with 60 actual trays installed.

The tray efficiency of approximately 96 percent is probably not unheard of for a tower of this diameter (approximately 7½ feet) but it is none the less good. The tray performance of the 3-foot alkylate debutanizer shown in Table 2 is also very satisfactory. However, no attempt was made to calculate the efficiency of the trays in this tower because the normal butane content of the bottoms was not reported. The 130 F. initial boiling point of the light alkylate and the over-all material balance suggest that the normal butane content of the debutanizer bottoms must have been very low but since no quantitative determination was indicated this efficiency was not calculated. The 36° gap (Table 3) indicated between the light and the heavy alkylate separated in the rerun tower is considered very satisfactory for the reflux ratio and number of trays involved. Such a gap indicates that the true boiling point overlap of these materials must be very small.

Table 4 summarizes some test information obtained during the operation of a catalytic reformer feed preparation column processing light straight run gasoline at the Augusta, Kan., refinery of Socony-Vacuum Oil Company, Inc. This tower was originally designed to obtain a 0 °F gap between the endpoint of the overhead and the initial of the bottoms at a reflux ratio of 1.0. In actual practice the data indicated in the first four columns on Table 4 indicate a 20° gap between the initial of the bottoms and the endpoint of the overhead. A true boiling point distillation on these same samples under this condition indicated a true boiling overlap of about 1 percent. During a companion test

TABLE 1
Alkylation Deisobutanizer

Tray Description:			
Type of Operation	Deisobutanizing		
Tower Diameter	7'-6"		
Tray Type	3 Section DXF		
No. of Trays	60		
Operating Conditions	**Feed**	**Bottoms**	**Overhead**	**Reflux**
Flow:				
BPSD	4836	1595	3245	15990
Moles/Hour	625	163	462	2280
Temperature, F	202[1]	337[2]	125	118
Pressure, psig	....	....	115	....
Stream Composition, Mole %:				
Propane	2.2	....	3.1	....
Isobutane	69.3	0.1	94.0	....
Butene	0.1	0.2	....	....
N-Butane	7.9	25.2	1.7	....
Isopentane	1.0	0.2	1.2	....
Lt. Alkylate[3]	18.0	69.0	....	....
Hvy. Alkylate	1.4	5.3	....	....
Totals	100.0	100.0	100.0	....

Calculated Results:	
Vapor Loading,	
Percent of Allowable:	
Top	94
Bottom	36
Reflux, L/D:	
Min. Theoretical[4]	2.9
Actual	5.4
Boil-Up Ratio V/W	5.7
Min. Theo. Trays at Infinite Reflux	37.7
Tray Efficiency	96.5

[1] Feed preheated by steam from 85 to 202 F.
[2] Heater outlet temperature: Bottoms product temp. 263 F.
[3] Isopentane content of alkylate was not reported.
[4] Isopentane in overhead taken as N-Butane.

TABLE 2
Alkylation Debutanizer

Tray Description:			
Type of Operation	Debutanizing		
Tower Diameter	3'-0"		
Tray Type	2 Section SXF		
No. of Trays	30		
Operating Conditions	**Feed**	**Bottoms**	**Overhead**	**Reflux**
Flow:				
BPSD	1595	1306	289	684
Moles/Hour	163	121	42	99
Temperature, F	283[1]	297	127	83
Pressure, psig	....	....	70	....
Steam Composition, Mole %				
Isobutane	0.1	....	0.8	....
Butane	0.2	....	0.8	....
N-Butane	25.2	....	98.0	....
Isopentane	0.2	....	0.9	....
Lt. Alkylate[2]	69.0	92.8	....	....
Hvy. Alkylate	5.3	7.2	....	....
Totals	100.0	100.0	100.0	....

Calculated Results:	
Vapor Loading,	
Percent of Allowable:	
Top	40
Bottom	30
Reflux, L/D	2.5
Boil-Up Ratio, V/W	0.75

[1] Deisobutaniser bottoms temperature.
[2] Isopentane content of alkylate was not reported.

TABLE 3
Alkylation Rerun

Tray Description:			
Type of Operation	Alkylate Rerun		
Tower Diameter	4'-6"		
Tray Type	4 Section SXF		
No. of Trays	20		
Operating Conditions	**Feed**	**Bottoms**	**Overhead**	**Reflux**
Flow:				
BPSD	1375[1]	197[1]	1178	410
Moles/Hour	125	13	112	39
Temperature, F	297[2]	393	234	85
Pressure, psig	....	....	1	....
Stream Inspections				
Gravity, °API	....	50.5	70.2	....
ASTM Dist., °F.:				
IBP	....	358	130	....
10 percent	....	365	176	....
30 percent	....	371	205	....
50 percent	....	378	220	....
70 percent	....	388	230	....
90 percent	....	445	246	....
End Point	....	524	322	....

Calculated Results:	
Vapor Loading,	
Percent of Allowable:	
Top	77
Bottom	56
Reflux, L/D	0.77
Boil-Up Ratio, V/W	9.5

[1] Feed includes 60 B/SD recycled heavy alkylate—Net heavy alkylate 128 B/SD.
[2] Debutaniser bottoms temperature.

run (see the second four columns of Table 4) this operation was conducted at a lower reflux ratio (0.65) and the gap between overhead and bottoms products was reduced to approximately 5 F.

The data summarized in Table 5 was taken during a test period, while thermal gasoline was being charged to the debutanizer designed for a 3000-barrel-per-stream day catalytic reformer. Since this tower was very amply rated at 3-foot minimum diameter for the design requirements of the reformer and since less than 2000 barrels per stream day of unstable thermal gasoline were available, the two test periods summarized indicate very low vapor loading, especially the period at the lower reflux ratio. Additionally, the feed point location was adverse for the thermal debutanizing test operation. Although the calculated 48 percent tray efficiency is considerably lower than is usually anticipated for this type of operation, it is none-the-less worthy of mention because of the adverse conditions prevailing. The fact that tray efficiencies in very small towers are generally lower than found in larger towers, because of the reduced composition gradient across the tray, and that tray performance is generally poorer under conditions of low loading because of poorer contacting and proportionately greater leakage, explains this low efficiency to a great extent.

Fragmentary data from an atmospheric crude distillation unit which commenced operation in the fall of 1954 is summarized in Figure 6. This distillation unit is located in the Ferndale refinery of General Petroleum Corporation where, incidentally, Uniflux trays are now in service in all of the distillation columns in this new 35,000-barrel-per-stream-day light products refinery. Because of technical manpower limitations during the early stages of this refinery operation it has not been possible to secure all of the data required to permit the determination of tower heat and material balances to facilitate the determination of vapor loadings and tray efficiencies. It is estimated that the vapor loading in this tower is in the range of 60-80 percent of the normal design allowable.

Limited data deter drawing firm conclusions, but it appears that Uniflux tray efficiencies are at least equivalent to those of well-designed bubble cap trays. Experience with Uniflux trays has led to their complete acceptance throughout the Socony Mobil organization.

TABLE 4—Catalytic Reformer Feed Preparation

Tray Description:								
Type of Operation	Straight Run Gasoline Fractionation							
Tower Diameter	7'-6"							
Tray Type	10 Section SXF							
No. of Trays	30							
Operating Conditions:	**Feed**	**Bottoms**	**Overhead**	**Reflux**	**Feed**	**Bottoms**	**Overhead**	**Reflux**
Flow, bpsd	5741	2610	3131	3276	5609	2595	3104	2044
Temperature, F	217	330	215	131	220	324	220	136
Pressure, psig	....	16	....	....	....	16	....	....
Stream Inspections Gravity, °API	65.4	56.1	73.9	....	64.8	56.1	74.3	....
ASTM Distillation, °F.:								
Initial Boiling Point	106	252	93	....	110	247	94	....
10 percent	154	260	125	....	158	257	126	....
30 percent	196	265	151	....	198	264	152	....
50 percent	225	271	171	....	227	270	172	....
70 percent	250	280	186	....	253	279	188	....
90 percent	284	296	200	....	288	297	204	....
End Point	336	334	232	....	330	328	243	....
Calculated Results:								
Vapor Loading, Percent of Allowable;								
Top			80				63	
Bottom			79				55	
Reflux, L/D			1.35				0.87	
Boil-Up Ratio, V/W			2.7				1.9	

TABLE 5—Thermal Gasoline Debutanization

Tray Description:								
Type of Operation	Debutanization				Debutanization			
Tower Diameter	3'-0"				3'-0"			
Tray Type	2 Section SXF				2 Section SXF			
No. of Trays	30				30			
Operating Conditions	**Feed**	**Btms.**	**Ohd.**	**Reflux**	**Feed**	**Btms.**	**Ohd.**	**Reflux.**
Flow:								
BPSD	1627	1436	....	891	1722	1557	....	442
Moles/Hour	171	139	32	....	181	151	30	....
Temperature, °F	70	336	125	108	63	341	128	110
Pressure, psig	....	104	....	96	....	100	....	95
Stream Composition, Mole Percent:								
Acid Gases	....	....	0.3	....	....	....	0.2	....
Methane	0.6	....	2.9	....	0.5	....	2.9	....
Ethene	0.2	....	1.0	....	0.1	....	0.6	....
Ethane	2.5	....	13.3	....	1.9	....	11.8	....
Propene	1.5	....	8.0	....	1.3	....	8.0	....
Propane	5.8	....	31.3	....	5.6	....	34.1	....
Iso-Butane	0.9	....	4.8	....	0.8	Trace	5.0	....
Butenes	2.9	0.4	14.3	....	2.8	0.8	13.4	....
N-Butane	5.2	0.9	23.9	....	5.0	1.3	23.5	....
Iso-Pentane	3.0	3.7	0.2	....	2.8	3.3	0.4	....
Pentenes	5.7	7.0	....	....	5.3	6.3	....	....
N-Pentane	5.8	7.1	....	....	5.4	6.4	....	....
Hexanes Plus	65.9	80.9	....	....	68.5	81.9	....	....
Total	100.0	100.0	100.0	....	103.0	100.0	100.0	....
Calculated Results:								
Vapor Loading, Percent of Allowable:								
Top			39				22	
Bottom			38				18	
Reflux, L/D:								
Min. Theoretical			1.2				1.2	
Actual			4.3				2.3	
Boil-Up Ratio, V/W			0.8				0.4	
Min. Theo. Trays of Infinite Reflux			10.4				8.1	
Tray Efficiency			48%				46%	

TABLE 6—Atmospheric Crude Distillation

Tray Description:								
Type of Operation	Crude Distillation							
Tower Diameter	12'-6"							
Tray Type	20 Section DXF							
No. of Trays	33[2]							
			ASTM DISTILLATION					
	BPSD	**°API**	**IBP**	**10%**	**50%**	**90%**	**EP**	**Flash**
Guleo Crude	26,550	33.4	....	....	....	....	....	....
Gas	....	....	....	....	....	....	....	....
Debut. Gasoline	3,700	67.5	89	102	160	212	236	....
Naphtha	2,930	50.0	243	255	271	301	344	....
Stove Oil	7,190	37.5	358	402	459	544	570	184
Gas Oil	1,460	31.5	546	596	606	640	678	230+
Topped Crude	11,460	30.2	....	....	....	....	....	....
Canadian Crude	30,000	40.0	....	....	....	....	....	....
Gas	....	....	....	....	....	....	....	....
Debut. Gasoline	6,370	67.5	92	118	160	198	230	....
Naphtha	4,630	50.8	250	272	300	340	366	....
Diesel	6,310	....	376	430	471	570	612	172
Gas Oil	2,270	37.7[1]	380[1]	430[1]	494[1]	596[1]	630[1]	170
Topped Crude	11,260	22.9	....	....	....	....	....	....

[1] Blend of diesel and gas oil sidecuts. [2] Does not include four 12'-0" 18 section DXF stripping trays.

Original presentation was before the N. Y. Section, American Institute Chemical Engineers, March, 1955. #

Trends in Turbine Development

Compressor driver speeds and horsepower have increased over 50 percent and the trend is still up.

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AS A RESULT of the growth of the refinery, chemical and petrochemical industries, a demand has been created for machines to handle large volumes of gases. Centrifugal compressors, improved by the accelerated development during World War II, proved to be the ideal machines for this application. Thus a demand was created for high-speed, high-capacity mechanical drive turbines.

It is important to define the terms high-speed and high-capacity as used in the steam turbine field. The speeds of these units generally fell between 1000 and 6000 rpm; and 5000 horsepower was considered a large rating. With the coming of the high-speed centrifugal compressor, speeds and horsepowers have crept upward until speeds from 6000 to 12,000 rpm are not uncommon, with ratings from 4000 to 10,000 horsepower.

To give a clearer picture of this trend, the curve of capacity versus speed has been included in Figure 1.

Extending existing turbine designs to proportionately larger sizes has been done to some extent. However, as speeds increase, diameters must be reduced to keep stresses within acceptable limits. As ratings go up the flow area must increase and blade heights become larger. Thus these compressor-drive turbines have quite different proportions from their lower speed predecessors.

The problems associated with high-speed designs fall chiefly into three groups, namely: (1) stress problems resulting from the high rotor speed, (2) the wearing of parts which may come in contact with the rotor, and, (3) vibration and critical speed phenomena.

The first, or stress, type of problems can usually be solved by direct calculation before a machine is built. For a given rotor size, increased speed can be obtained only through the use of stronger materials, or the ingenuity of the designer in making more efficient use of a given weight of material.

The second and third groups of problems—those associated with wear and vibration—are of such a nature that design data are best obtained from the operation of actual machines. Several turbines now being built for installation in the laboratory early in 1955 have been designed to yield to such data.

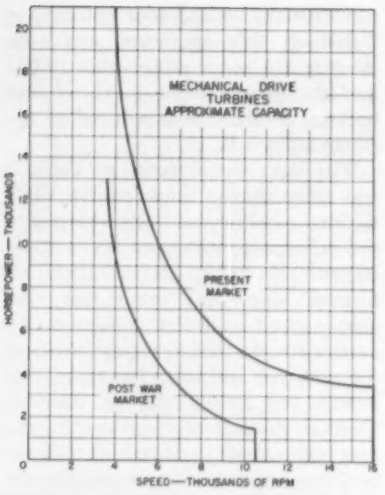

FIGURE 1 — Capacity curves for mechanical drive turbines.

Wear generally is a function of surface velocity, so that high rpm values would not present a problem if rotor diameters could be kept small. However, the increase in turbine ratings results in larger shaft diameters to transmit the increased torque.

The parts that must necessarily be physically close to the rotor are the bearings, shaft seals, blade seals, and drive gears for the governor and oil pump. Of these, the bearings perhaps present the least difficulty since the parts moving relative to each other are separated by a film of oil.

The shaft seals, or glands, and the blade seals, being in the steam space, cannot be lubricated and so require special attention. These seals are designed to clear the rotor under normal operation; however, the clearance must be as small as possible in order to keep steam leakage to a minimum. With such small clearances, rubs may occur due to thermal distortion during start up periods, or other transient conditions involving large temperature changes. To prevent major damage when such rubs occur, the seals are designed to yield or wear without damaging the rotor. Finding the best design and material combination, and the minimum permissible clearance is most readily done by testing.

Though governor drive gears can be lubricated, misalignment and distortion can still cause excessive wear. Here again, the best design is most easily developed through tests. ##

Two turbines, now under construction for the laboratory, have been designed to enlarge the present scope of knowledge regarding the solution of problems. One, 10,000 horsepower at 13,000 rpm, has a rating quite a bit higher than present market requirements. The turbine has been designed to accommodate several gland designs interchangeably so that various types can be compared under actual operating conditions.

The second turbine is being built to operate at a maximum speed of 25,000 rpm with a capacity of 200 horsepower. The chief function of this machine will be to run various mechanical spin tests on bearings, glands, rotors, etc.

New Reformer Features . . .

All-Electronic Instrumentation

. . . A report on design considerations, installation, and operating and maintenance experience.

F. C. Somers and R. C. Fuhs
The Atlantic Refining Company
Philadelphia, Pennsylvania

CONTROLLING operation of The Atlantic Refining Company's new catalytic reformer at Atreco, Texas, is an electronic system selected by the Engineering and Construction department after a careful evaluation of the latest available equipment.

Developments in instruments and controls, particularly along electronic lines, indicated in the preliminary design stage that a reappraisal was necessary of both pneumatic and electronic types. It was felt that a first-class, thoroughly modern installation should satisfy these requirements:

(a) Operate dependably and accurately.

(b) Offer low first cost. As the number of instruments and controls has increased, the cost of the equipment and interconnections has required closer scrutiny. The skilled labor required for the tubing work between pneumatic transmitters and controllers, plus the costs of such auxiliaries as air compressors, filters, driers, indicated the feasibility of investigating electronic equipment.

(c) Require minimum size control house. That the trend in control houses is strongly in the direction of larger and more elaborate buildings is apparent to all. Unfortunately, the consequences in terms of over-all cost of the instrument installation are not always appreciated.

(d) Require minimum operating personnel. Some instrument panels cover so much space that they require the attention of several operators.

(e) Require less maintenance and be easier to maintain when maintenance is required.

(f) Be adaptable to incorporating probable future developments in the field of automation.

FIGURE 1—Console containing all instruments and controls looks like this to the operator.

Although operating experience was practically non-existent at the time, the marked reduction in moving parts and the inherent accuracy and absence of time lag in electrical measurements led to the conclusion that the operation of an electronic system was potentially more dependable, as well as more accurate. Economic studies indicated the installed cost of the electronic system was about 12 percent less than for an eqivalent pneumatic system. Equipment costs were not significantly different. Differences in installation costs, and particularly the differences in the cost of electric wiring versus pneumatic tubing, accounted for much of the saving. A number of possible control house layouts using the various types of instruments were investigated, and it was concluded that electronic instruments in a console arrangement would result in minimum size control house.

Employing electronic instruments in a console arrangement produces an extremely compact arrangement with all instruments and controls readily visible and accessible to a single operator. As can be seen from Figure 1, the console is not much larger than a conventional desk. Such compactness and accessibility is most desirable when operating with a minimum

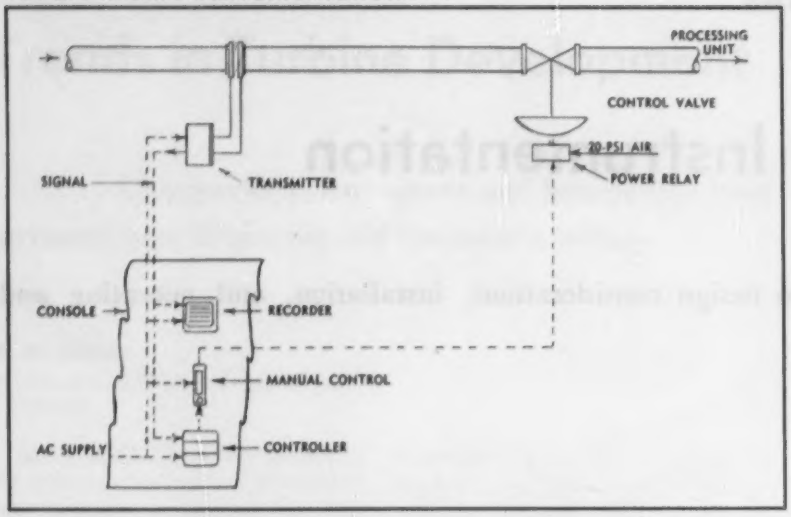

FIGURE 2—Block diagram of typical flow control system.

number of shift operators.

The fact that electronic instrument equipment has few moving parts, none of which is delicate, points in the direction of less maintenance. The "plug-in" feature, in conjunction with the fact that control action can be preset to desired values without cut and try adjustments after installation, makes interchanging units a simple matter. Thus most maintenance work can be performed under favorable shop conditions.

Virtually all foreseeable future advancements, such as automatic data gathering systems, are based on converting the measured quantities to electrical units and from this standpoint, the electronic equipment is particularly advantageous.

The electronic system appeared favorable on all points, but there was not sufficient operating experience available to substantiate the conclusions. However, the potential advantages appeared great enough to justify pioneering a full-scale installation. Accordingly, it was decided to proceed with the design and installation of an electronic instrument and control system for the Catformer at Atreco.

The Electronic Instruments—The basic principle of the system employed, is the conversion of a measured variable to a 0 to 0.5 volt, 60-cycle, AC signal in the primary element or transmitter which is mounted near the measuring point. This signal voltage is transmitted to the recorder or indicator in the recording systems, or to the recorder and controller in the control systems. The controller converts the difference between the transmitter signal and the set point signal to a DC current. This current is transmitted through the manual-automatic selector switch, called the manual control, to the electric to pneumatic transducer, called the power relay. The air from the power relay actuates any standard diaphragm valve. The recorders, controllers, and manual controls are located in the central control house, while the power relay is mounted near its control valve. A block diagram of a control system is shown in Figure 2.

The mechanical design of instruments is a factor that is often overshadowed by considerations of operating principles and potential performance. Actually, sound mechanical design is the most fundamental consideration of all. It is the basic requirement for peak performance, stable operation, and reasonable maintenance. In selecting instrument equipment for this project, mechanical design received the consideration it deserves, and it is believed that the equipment used is outstanding in this respect.

Both recorder and controller are flush mounted, miniature, "plug-in" type, designed to require minimum panel space. A recorder or controller consists of a mounting frame which is permanently fastened to the panel with the recorder or controller proper being assembled as a removable chassis which plugs into the mounting frame. All external connections are made to a terminal strip at the rear of the mounting frames. Connections from the mounting frame to the removable chassis are made through a plug and socket arrangement. This construction permits the controller and recorder to be easily removed from its mounting frame without disturbing any external connections.

List of Instruments—A complete list of the instrumentation installed is as follows:

(1) Twenty recording systems, consisting of nine flows, six pressures, and five temperatures. (Electronic Transmitters and Recorders.)

(2) Fourteen controlling systems, consisting of six flows, five pressures, and three temperatures. (Electronic Transmitters, Recorders, and Controllers.)

(3) Forty thermocouple points. (Read on an electronic type indicating potentiometer).

(4) Four liquid level indicators and controllers. (Pneumatic type)

(5) Two liquid level controllers. (Pneumatic Controllers—locally mounted)

(6) Two high level alarms. (Triggered by float actuated switches)

(7) The operation of all compressors and pump drives is monitored by running lights.

(8) A cooling tower low water level and gas alarm.

(9) Speed Controllers on the four compressors. (Pneumatic-locally mounted)

With respect to items 4 and 5, pneumatic liquid level controllers were selected because a suitable electronic instrument was not available. Two of these level controllers are "blind" controllers, while four have the level indicated on the console. These four levels are the only signals pneumatically transmitted to the control house. Pneumatic speed controllers were chosen because they are completely locally mounted instruments and electrical transmission and control was not considered necessary.

Control House and Console—All instrumentation, with the exception of the compressor speed controllers, is mounted in a console type panel located in the control house (Figure 1). A console has the advantages that all controls are visible to the operator at a glance, and it can be fabricated, tested, and shipped as a complete unit. This latter feature greatly eases the installation problems, since only a comparatively simple field recheck is necessary. Although it is often over-

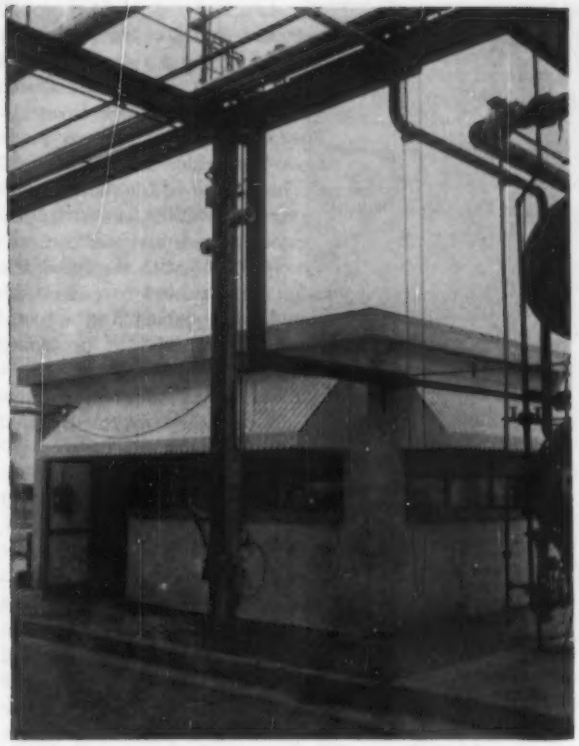

FIGURE 3—This wiring duct carries all wiring between the unit and the control house.

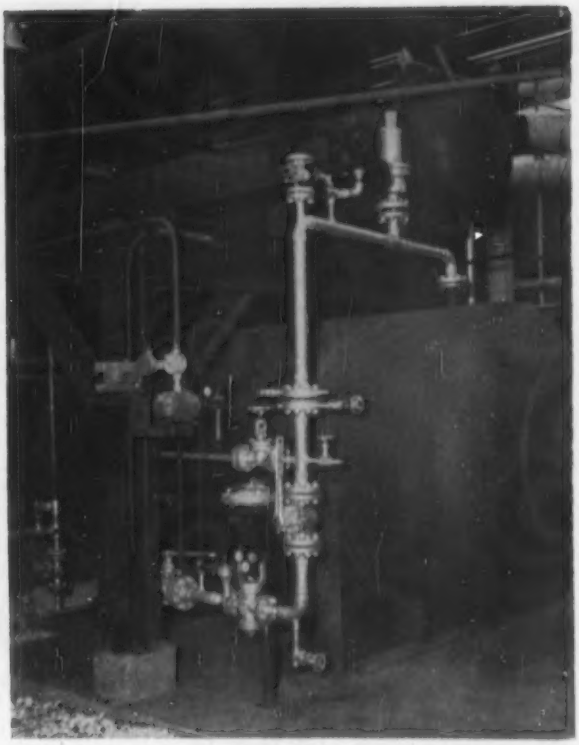

FIGURE 4—Typical remote installation showing transmitter power relay and diaphragm operated control valve.

looked when estimates and comparisons are made, the cost of the control house is a large part of the total instrumentation investment. As an example of the economies that are possible by a combination of miniature instruments in a console arrangement, the control house for this plant, which is pictured in Figure 2, is only 14 by 25 feet inside. The area of this house is only 350 square feet as compared to 900 square feet required for another recently constructed catformer using standard size pneumatic instruments.

Normal Instrument Power System—The console presents a load on the 115-volt system of approximately 1500 va. This power is fed by one circuit but in the console, it is subdivided into two main groups:

(1) The instruments, which are fed through a 2000-volt amp constant voltage transformer.

(2) Accessory equipment (clock, running lights, etc.), which is fed directly from the line.

The constant voltage transformer serves as an isolating transformer, since the instruments have one side of their power circuit grounded and are being fed from a 115-volt ungrounded system. The instruments are the null balance type and are not affected by nominal voltage variations; hence the constant voltage feature is not absolutely essential.

The power supply circuit, along with all the power and signal wiring from the transmitters and power relays, is brought to the console through a single metal cableway. All circuits terminate at terminal blocks in distribution boxes located in the console.

The controllers and recorders have internal circuit protection; however, additional protection is required to isolate separate systems from the main feeder. In the recording system, the circuit protection is arranged to isolate both the recorder and its associated transmitter in case of failure of either. The protection for the control system removes the transmitter, recorder, and controller in case of failure in either, and separate circuit protection is provided for the manual control and power relay. This permits the valve to be operated manually from the control house in case of failure in either the transmitter, recorder or controller. It is also possible to have a record of the controller variable while on by-pass control in case of failure in the power relay.

Accessible from the rear of the console are individual mercury type control power switches for each recorder and its tranismitter, each controller and its recorder and transmitter, and each manual controller. The mercury switches have one disadvantage—if the console is accidentally jarred, the mercury contact is momentarily broken. This brief interruption of power does not upset the control action, but it does produce "pips" on the recording charts.

Emergency Instrument Power System—Although the plant is not designed to operate in cases of complete electrical power failure, it was considered necessary to provide the instruments with emergency power to protect against an abrupt loss of control. Rather exacting emergency power requirements were imposed by the instrument manufacturer to insure continuous operation of the instruments at their guaranteed accuracy. These requirements were: (1) a maximum of three-second interruptions and (2) supply to have a plus or minus 3-cycle per second frequency regulation. (The voltage regulation was not critical, since power is fed through a constant voltage transformer.)

An existing emergency power system supplied by a 20-kw steam turbine was available in a nearby process unit. Tests indicated this turbine generator required five to ten seconds to come from rest and deliver rated voltage. To meet the three-second requirement, it was necessary to install a special emergency system for instrument and control power. This auxiliary unit is continuously operating and capable of delivering power immediately when called upon. The installation consists of an AC motor, an AC generator, a DC unit (motor or generator), all on the same shaft, a storage battery, and a control cabinet. The unit rotates continuously. Normally the AC motor drives the AC generator and the DC unit, which acts as a generator to maintain the battery in a fully charged condition. If power fails, the battery supplies power to the DC unit, which acts as a motor to drive the AC generator.

The battery will supply the load of the console for about a half hour. To conserve the battery and to permit emergency operation for longer than one-half hour, the instrument system load is transferred to the previously-mentioned 20-kw turbine generator as soon as it is up to rated speed and voltage.

Experience indicates that the emergency power requirements imposed were more exacting than necessary for this plant. These requirements may be justified for continuous operation at the guaranteed accuracy; however, since the purpose of this plant's emergency system is only to bring the unit to a gradual shutdown, extreme accuracy is not required. Field tests, plus an unexpected complete power failure, indicate that instrument power may be off for up to ten seconds and still maintain satisfactory control for making an orderly shutdown of the unit.

Interconnecting Wire—A single metal cableway carries all wiring between console, transmitters, thermocouples, and power relays. It is mounted on pipe supports and is "T" shaped in its layout. One leg runs the entire length of the plant, and from it another leg is sent through the reactor-furnace section. A photograph of the cableway from the unit to the control house is shown in Figure 3. This type of construction was chosen over conduit for its initial economy of material and labor and its future flexibility. Most processes undergo expansion and refinements over the years, and the instrumentation must keep pace. The cableway system greatly simplifies the problem of relocating or adding instruments. Except for the control house, which has special cableway, the cableway has a cross section of 4 by 6 inches. It is made of 16-gauge hot dipped galvanized iron. Its U-shaped channel lid is fastened to the duct with sheet metal screws and sealed with a neoprene gasket. Branch connections from the cableway system to the field transmitters, power relays, and thermocouples are made with rigid steel conduit. A seal fitting is provided in all conduits at the end away from the duct. A typical installation is shown in Figure 4.

All wiring consists of multiconductor cables. Except for thermocouple leads, the insulation and jackets are of the thermoplastic type. The transmitters use a special four-conductor cable made up of two shielded No. 22 AWG stranded and twisted wires for the signal leads and two unshielded No. 20 AWG stranded and twisted wires for the power to the transmitter. The power relay cables are made up of two unshielded stranded No. 20 wires. This wiring is adequate for installations up to 1000 feet in length. Thermocouple leads are iron-constantan, No. 16 AWG, with thermoplastic insulation, and cabled in pairs with a cotton lacquer jacket and a metal braid over-all. Instead of providing spare conductors in each cable, several spare cables of each of the above types were included in the original installation. These spare cables extend the full length of the duct system and thus may be picked up at any point desired.

Transmitters and Power Relays—The transmitters and power relays have explosion-proof enclosures approved for Class I, Group D, Division 1 locations. There is little difference between the installation of this type of equipment and pneumatic equipment. The transmitter should be mounted as close as possible to the measuring take-off point for accuracy and rapid response, yet mounted at convenient height for maintenance and calibration. The pressure and differential pressure transmitters can be calibrated by hanging dead weights from a point at the rear of the transmiter lever assembly. See Figure 5. To take advantage of this feature, the transmitter must be mounted upright and with no obstruction at least 18 inches below it. Transmitters are equipped with their own dampening device, which permits the transmitter to be mounted in areas of normal vibration generally found in refinery work without special precautions. In locations subject to unusual vibration, it has been found necessary to provide separate and more rigid mounting, rubber vibration absorbers between the mounting bracket and the transmitter, and a section of flexible hose in the metering lines. Power relays are not equipped with any internal dampening and are rigidly mounted.

As mentioned, this plant has 15 flow transmitters, all of which are the D/P type. Teflon diphragms were selected over steel because of their superior corrosion resistance and characteristic minimum zero drift.

Meet the Authors

FRANK C. SOMERS, manager of the Engineering Research division of The Atlantic Refining Company's Engineering & Construction department, joined the company in 1953, after 10 years with Standard Oil Development Company. An electrical engineering graduate from Duke University, he also holds a masters degree from Massachusetts Institute of Technology. Somers' other industrial experience includes service with Communications Development Company in Camden, N. J., and Lago Oil & Transport Company at Curacao in the Netherlands West Indies.

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RICHARD C. FUHS, who is a junior engineering assistant in the same division with Somers, started with Atlantic in March 1954. He is a graduate of Villanova University, where he obtained a B.S. degree in electrical engineering in 1950. A veteran of two years' service in the Navy during World War II, he worked four years as an engineer in the U. S. Naval Air Experimental Station, following his graduation from college.

The diaphragms for the pressure transmitters are stainless steel.

The primary element for a temperature recorder or controlling system may be any thermocouple or resistance element. This installation employs iron-constantan thermocouples, with a thermocouple-converter located in the console. The thermocouple-converter is designed to convert the thermocouple DC millivoltage to the base 0-0.5 v, 60 cycle AC/signal to feed other instruments in the system. The thermocouple-converter has both adjustable zero suppression and adjustable range. The field mounted primary elements as installed here have one shortcoming—they are blind transmitters; that is, they do not provide a local indication of the measured variable. However, this problem has since been overcome and an instrument for a local reading is now available.

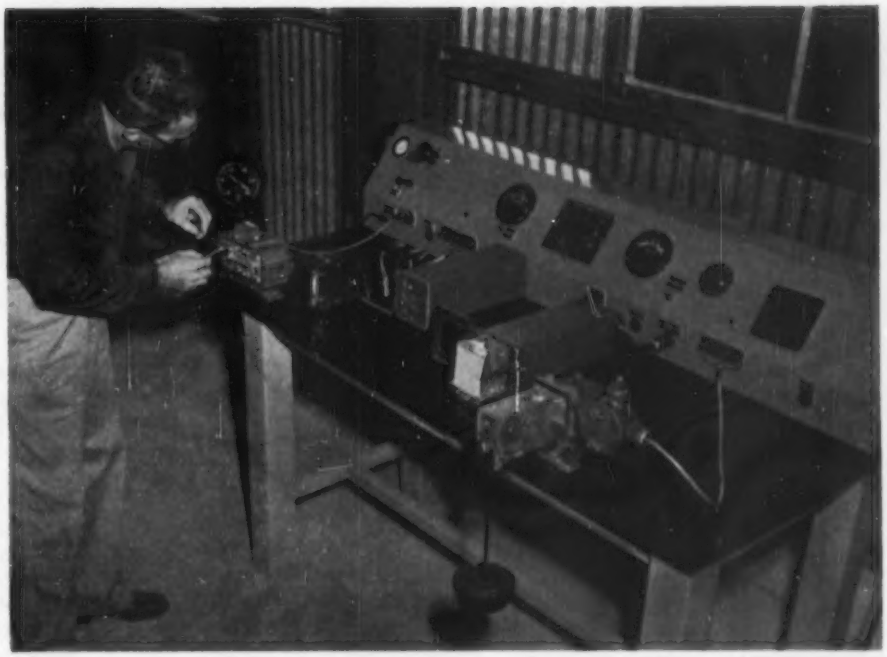

FIGURE 5—Test bench used for maintenance and calibration of the electronic instruments.

Operation

Performance of the instrument installation during start-up and subsequent operation has exceeded expectations. As with all new developments, a period of finding and eliminating the "bugs" was anticipated, but in this case the "bugs" never materialized. The start-up of the plant was completely free of instrument problems. Operations to date have been characterized by the same performance and it is apparent that there are no problems peculiar to this electronic system.

Adjustment and Calibration—During start-up, the optimum settings for proportional band, automatic reset, and rate action were found by the usual "cut and try" procedure. The standard controller has a range of 2 to 200 percent proportional band, 0.3 to 20 repeats per minute automatic reset action, and .05 to 8 minutes rate action. Standard controllers are used for the three temperature controls, while flow and pressure controllers have standard proportional band with a fast acting automatic reset action (.03 to 240 repeats per minute), but no rate action. The adjustments made during start-up clearly indicated that faster rate times are possible with the electronic system than with a pneumatic system. Although direct comparisons were not made, it is estimated, based on past experience, that rate times used in this installation are 50 percent faster than for a pneumatic system. The faster rate times make it possible to hold the controlled variable within a closer tolerance to the set point. Optimum settings for proportional band and automatic reset action were found to be comparable to similar settings for a typical pneumatic system.

Equipment Problems—The few difficulties that have been experienced have been of a type common to instruments in general. For example, several chart drive motors have failed, but the "plug-in" feature of the instruments greatly simplifies this problem in that a spare recorder can be placed in service and the faulty instrument repaired more conveniently and quickly in the instrument shop. There are also several instances of zero drift in the flow transmitters D/P cells which fault is common to most D/P cells and corrected by the usual "working in" technique. Repeated failure of a flow transmitter metering the recycle gas on the discharge header of four compressors occurred. The use of pulsation dampeners and a heavier assembly for the transmitter supplied by the instrument manufacturer solved the problem.

Operating Advantages—Speed of response of the instruments is definitely faster as compared with similarly installed pneumatic types. However, because of the limitations of pneumatic control valves, it has not been possible to take full advantage of this feature.

The accuracy of the electronic measuring recording system is one half of one percent. Unstable calibration has always been a problem with older types of instruments. However, the inherent stability of electronic instruments makes it possible to maintain accurate calibration for indefinite periods of time. Another operational advantage of this type of equipment is the fact that the recorder pen is completely dissociated from the controlling action. Thus accidental deflection of the pen during inking operations, etc., does not affect control action. A very significant accomplishment is the fact that the entire catformer is being operated by two men per shift. The electronic instrument system is not primarily responsible for this. However, it is

certain that the ease and dependability of operation of the controls, together with the fact that the console arrangement makes all controls and instruments readily accessible and visible to a single operator, has been a factor.

Maintenance

It is intended that plant personnel handle the maintenance of this equipment, and no difficulty has been experienced in carrying out this plan. The maintenance of electronic equipment is not completely foreign to the average instrument department in that electronic equipment in the form of temperature recorders has been in wide use in the process control field for many years. However, because of the scope of this project and the many details of a new system, a definite maintenance program was set up. The plan carried out was to have an Atlantic Refining Company engineer visit the instrument manufacturer for one week to be given extensive instructions. The engineer then conducted a training program at Atreco in the operation and maintenance of the installation. Training was given to both operating and maintenance personnel.

Test Faculties—To facilitate the instruction at the refinery and to simplify maintenance, a special test set-up was made. See Figure 5. The set-up is built around a portable test unit which supplies simulated transmitter and set point signals and which is so mounted in the panel to be easily removed for field checks. The bench also incorporates an adjustable voltage supply, an adjustable and regulated air supply, a voltmeter reading supply voltage, and a milliameter for controller output current. A vacuum tube voltmeter is used to read check point voltage when the set-up is used for maintenance work. This set-up makes it possible to assemble a complete control loop for system calibration and to serve as a demonstrator for class instruction. It also provides convenient outlets for test and calibration of the individual units of the system. The cost of material for this set-up was approximately $250, which can easily be justified by the time saved over repeated make-shift test set-ups and the consistent and accurate calibrations which are possible.

Maintenance Procedures—The practice followed in maintaining this equipment is to repair field mounted units, such as transmitters and power relays, on the spot if possible. Console mounted instruments, are returned to the instrument shop, where they can be maintained more efficiently. It is comparatively easy to isolate a system failure to a particular unit, i.e., recorder, controller, etc. If the faulty unit cannot be conveniently or quickly repaired on the site, it is replaced with a spare instrument. The faulty unit is then set up on the test bench, and through a system of check point voltages, the trouble may be isolated to a particular section or component. Once the trouble is located, the unit is repaired and recalibrated and then placed in stock as a spare. Consistent and stable calibration and the ability to accurately preset control functions permit random interchange of units of the system.

Maintenance Experience—No unusual maintenance problems have been experienced; however, the installation has not been in service long enough to clearly establish maintenance requirements. It will be recalled that one of the factors influencing the decision to make this installation was the fact that maintenance requirements would be reduced and simplified. So far, the indications are that this expectation may be realized. The ready interchangeability of equipment, the test and calibration bench, and the standardized procedures established already have demonstrated that normal maintenance can be accomplished with minimum disruption of the process.

There have been no tube failures to date. A program of tube replacements at regular intervals has not been established but will be considered when sufficient data on tube failures are accumulated. It is interesting to note that industrial long-life tubes are used for the controllers, while standard tubes are used for the recorders. Since a recorder can be removed for repairs or tube replacement without disturbing control action, the use of industrial tubes costing approximately five times as much as standard tubes appeared uneconomic.

A complete stock of all necessary component parts for all anticipated maintenance has been established. In addition, complete spare recorders, controllers, transmitters, power relays, etc., are stocked on the basis of one spare unit for every ten units in service with a minimum of one spare unit of each type. Based on operations to date, it appears that the number of spare units could be safely decreased.

Conclusion

The obvious questions to ask after venturing into a new field such as this are: (1) Have the objectives been accomplished? (2) From the experience gained, what changes will be made in future installations? The answer to the first question is a definite "yes." The start-up was made without delay because of instrument failures, and subsequent operation has been continuous and dependable. There have been no troubles peculiar to electronic systems, and while it is too early to draw conclusions regarding maintenance, it is clear that the electronic instruments can be maintained easily and without disruption of plant operation.

The plant is operating with two men per shift and improvement in control action has been realized. Savings in first cost have not materialized to the extent originally estimated, largely as a result of expenditures on an emergency power system that experience has shown were unnecessary. A valuable and reliable amount of experience in all phases of electronic instrumentation has been acquired which will be exploited in future installations.

Although this first installation has been more than satisfactory, some improvements will be made in future installations on the basis of the experience to date. For example: (1) Future similar installations will not include such an elaborate emergency power system. (2) The field transmitters will have indicators near the control valve. (3) Electric or hydraulic control valves, if suitable ones are available, will be used where speed of response is significant. (4) Further simplifications and economies in interconnecting wiring will be adopted. (5) The absence of winterizing problems in cold climates will be exploited. (6) Initial stocks of spare instruments and parts will be reduced.

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Metals don't crystallize . . .

You Can Prevent Fatigue Failures

But you must inspect, stress analyze, fillet, avoid corrosion and streamline.

J. J. McKetta and W. G. Dudley,
Refiner Staff

IF YOUR grandfather worked around machinery, he *knew* that metals crystallized under repeated stressing and then broke. If he is still living, he still knows it; and more than likely you know it too. There are many *yous* among to-day's corporate executives, managers and even engineers.

The fact is, all metals are crystalline from the moment they freeze in the ingot mold. Subsequent working and heat treatment may change the size and shape of the crystals, but a piece of freshly machined shafting, sucker rod, unused drill pipe or high pressure tubing is just as crystalline as it will ever be in the most severe service.

All of today's scientific instruments, electron microscopes (capable of 25,000 magnifications), X-ray and electron diffraction, etc. have been applied to the problem of fatigue.[7] They all affirm that the crystalline structure of metals which have failed by fatigue is just the same as when they were new. Even the conservative and reliable National Bureau of Standards has published two bulletins entitled, "Metals Do Not Crystallize Under Repeated Vibration."[1]

If it will appease the "crystallizers" any, there are some slight observable changes near the origin of a fatigue crack. These are slip planes which are evidence of some cold work or plastic flow that has occurred as a result of stresses above the yield strength of the metal. Similarly, micro-hardness tests can detect a slight increase in hardness which is a consequence of this plastic flow. Some line broadening is also observed in x-ray diffraction. It should be emphasized that these changes are only observed near the origin of the fatigue crack. The rest of the section which has failed remains quite unchanged.

Extensive research has pretty well established the facts. The stresses necessary to cause a fatigue failure in iron or alloy steels are in the order of one-half their tensile strength. The joker in this picture lies in determining the designs or conditions which cause operating stresses to reach this magnitude. The designer may have estimated, in good faith, that his operating stresses are only one fourth of the tensile strength. If this is actually so, he will never have a fatigue failure.

The stress raisers[8] or notches upset his calculations. Most often, these take the form of abrupt changes in section such as shoulders on a shaft unrelieved by even the slightest fillet. Similarly, keyways are usually machined with sharp corners. Number stamps, corrosion pits[9] and tool marks may be just what it takes to exceed the endurance limit.

In tubular goods, the fatal notch may be a minute crack at the inside surface. Even seams and inclusions have a sorry effect on fatigue behavior. In defense of the steel maker, however, it is estimated that much less than one per cent of the fatigue failures which occur in industry are due to seams and inclusions. Their importance is none the less manifested in the superior behavior of "Aircraft Quality" steels, and more recently in the quite superior behavior of vacuum-melted steels. Aircraft Quality steels are subject to a rigorous magnetic powder inspection.

How Does a Fatigue Failure Occur? At some stress raiser such as discussed above, the repeated stresses cause the formation of a minute crack. Each additional cycle of stress causes the crack to propagate a little. A crack, of course, is the most severe stress raiser known, since it is the sharpest notch. When the crack has progressed anywhere from about a tenth to a third of the section, an abrupt brittle failure occurs without warning. This final fracture follows some crystal faces and crystal planes. The shiny facets of these crystal faces and planes gives the appearance which has created the term "crystallized." By introducing very sharp notches and severe loading, similar fractures can be obtained in metal which has never before been stressed in any manner.

How To Avoid Fatigue Failures—What we know about avoiding fatigue may be summed up in a few words: Know your stresses; eliminate stress raisers and keep operating stresses at safe limits. Unfortunately, there is more to estimating stresses and eliminating stress raisers than meets the eye. We will none the less attempt to discuss some of the more important aspects of these two problems.

Early in World War II, repeated fatigue failures of the crank shafts in a certain make of in-line plane engine defied metallurgy's best efforts at increasing strength and improving quality. Of course the torque loads in the shafts were known with ac-

curacy. The stress concentration at the shoulders could be estimated and it was relieved by generous filleting. What was not known was the torsional vibration in the shafts under operating conditions. These vibrations created stresses which exceeded the fatigue strength of the strongest and cleanest alloy steels tried. Electrical resistance strain gages are used to pick up vibrational stresses and transmit them to an oscillograph where they can be studied. In many pieces of equipment, the stresses are indeterminate, especially at the surface where they count the most in fatigue problems. Strain gages can provide a precise stress measurement under either static or dynamic conditions.[9] With apologies to some unknown photography enthusiast, it might be said that one strain gage is worth a thousand calculations.

Another tool of great importance in stress analysis is brittle lacquer.[8] When the component under study is loaded, the lacquer forms cracks normal to the major strains. The crack frequency can be used to estimate stresses. This technique is a valuable adjunct to the strain gage in that it covers an entire area, and it can be applied to locations for which the strain gage is not suited such as oil holes and fillets. Again, it provides information not always within reach of the theoretician.

Plastic models[6, 9] provide yet another very useful method of estimating stresses, When viewed under polarized light, the stressed models exhibit a series of rainbows, each spectrum corresponding to a certain increment of stress characteristic of the plastic used. Thus the actual stress concentration at the root of a thread or an unfilleted keyway can be estimated with some accuracy.

Speaking of keyways, full scale fatigue tests have shown that proper filleting will double the endurance limit of shafting.

How to Detect Cracks—The start of a fatigue failure is the formation of a small crack. In tubular goods, minute cracks several thousandths of an inch deep may occur on the inside diameter of new tubing. These defects carry over from tears and laps occurring in the piercing operation at the steel mill. Proof-testing at high pressures may not disclose their presence, but will possibly cause them to propagate a little, thus further weakening the tube.

Whether the cracks are originally present, or whether they are the result of fatigue, there is usually time to discover them.

Magnetic powder inspection seems to be one of the best, and certainly the most flexible methods of detecting cracks which occur at or near the surface.

With high-pressure piping, a length is filled with a kerosine suspension of the magnetic powder. While full, the pipe is given a shot of direct current. If the pipe is an alloy steel the current may be disconnected as the residual magnetism will be great enough to retain the magnetic particles on any defect to which they have been attracted. The inside surface is then inspected with an optical device made for this purpose. Periodic magnetic powder inspection is excellent insurance.

Light oil and whiting constitute one of the oldest methods of crack detection, and the method has several modern refinements which are very effective. The part to be inspected is wiped clean and then painted with a penetrating fluid. This is permitted to remain on the surface for about fifteen minutes. It is then wiped dry and covered with whiting or powdered chalk. To increase the effectiveness of the method, the penetrant may contain a brilliant dye or a material which will fluoresce under ultra violet light.

Supersonic methods are finding a well deserved place in this field. Their sensitivity has been greatly improved in recent years. In this method, a "head" coupled to the surface with oil or water transmits supersonic vibrations into the object being inspected. The vibrations are reflected back by a defect and the reflection is observed on an oscillograph. This method has two unique advantages. It will detect subsurface defects, and it can be used in place on the components of assembled equipment.

X-rays and radiography are also used, but to be effective, the radiation must be lined up with the plane of the crack. The advent of cheap radioactive isotopes such as cobalt 60 and low priced, compact, portable x-ray units has brought this tool within the reach of every fabricator and user of metals.

When is metal "crystallized"? or is it still safe? It is hoped that the reader, is convinced that metals don't crystallize. They are crystalline seven days a week with or without repeated stressing. If at some local surface area operating stresses reach a level in the order of half the tensile strength, a crack will develop. Periodic, intelligent and searching inspection by one or more of the methods discussed above will usually reveal fatigue cracks before they have become critically dangerous.

How Does a Fatigue Failure Occur?

"Repeated stresses cause the formation of a minute crack. Each additional cycle of stress causes the crack to propagate a little. A crack, of course, is the most severe stress raiser known, since it is the sharpest notch. When the crack has progressed anywhere from about a tenth to a third of the section, an abrupt brittle failure occurs without warning. This final fracture follows some crystal faces and crystal planes. The shiny facets of these crystal faces and planes gives the appearance which has created the term 'crystallized.' "

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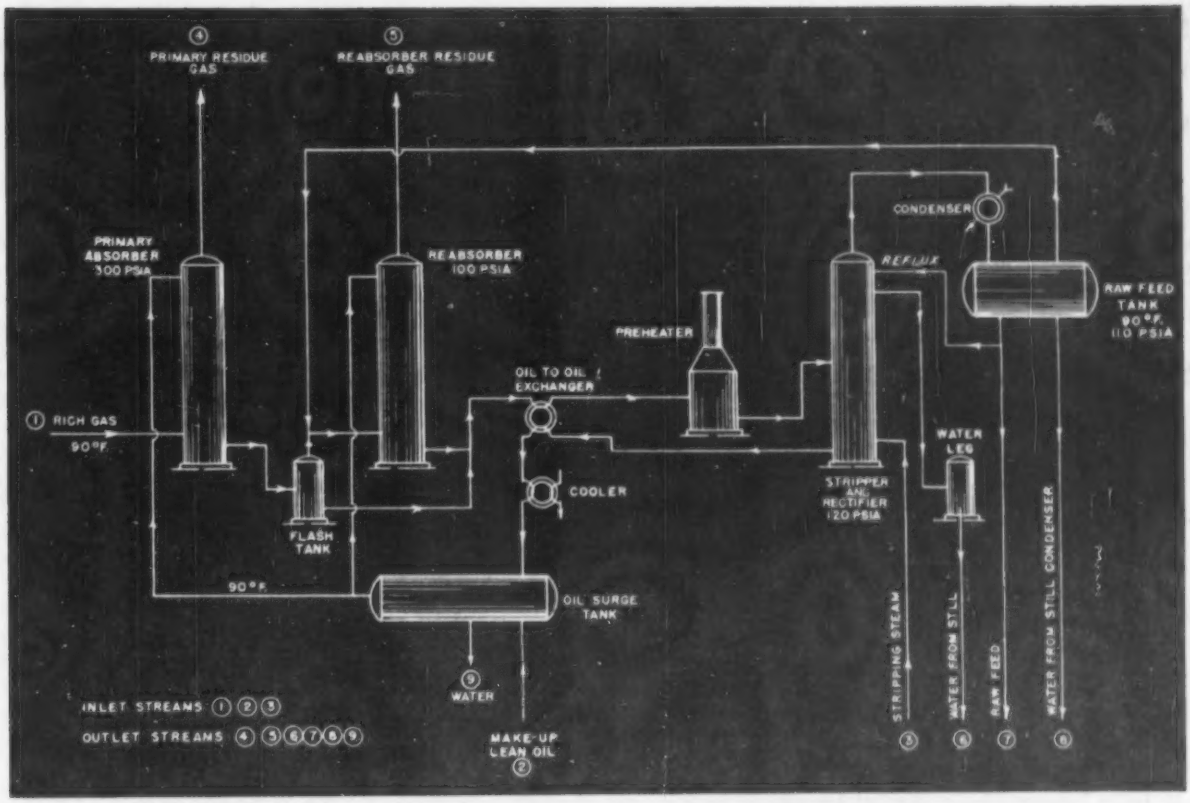

FIGURE 5—Flow diagram of an absorption plant: the basis for the design application.

From the files of a process engineer comes this method for engineering accuracy in . . .

Absorption and Stripping Design

Part 1. Basis for Design Method

Part 2. Example Calculation for Absorption System

Part 3. Example Calculation for Stripping System

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TO GIVE AN example of the application of a process design method of engineering accuracy when absorption and stripping systems are taken as one unit, a simplified process flow of an absorption plant, Figure 5, is used as a basis. Briefly, the absorption system of the plant consists of a primary absorber and a reabsorber. The stripping system consists of a stripper, a rectifier and their auxiliary heat exchange equipment.

The assumed operating pressures of various process equipment are shown in Figure 5. The plant inlet gas rate is assumed to be 10,000 pound moles per unit time at 300 psia and 90 F. The inlet gas composition is given in Table 1-A. The physical properties and ASTM distillation results of new absorption oil are given in Table 4. The cooling water temperature is such that the process streams cooled by water will be cooled to 90 F.

The absorption plant is to be designed so that about 69.5 percent of propane contained in the inlet feeds of the primary absorber and reabsorber is to be absorbed by the solvent. The rich oil to the stripping system is to be preheated to 400 F. and 80 percent of *n*-pentane contained in stripper liquid feed is to be stripped

with steam as the stripping medium.

By presenting illustrative process design calculations in tables in this series, it is shown how the following important variables for the above example are evaluated.

1. Recovery of various components as liquid in the raw feed.
2. Lean oil circulation rate for the primary absorber and reabsorber.
3. Stripping steam requirement for the stripper.
4. Rectifier overhead-vapor temper-

TABLE 1-A—First-Go-Around Calculations for Primary Absorber

(Basis: 10,000 Pound Moles Per Unit Time Inlet Gas at 300 psia and 90 F. Absorption Oil Inlet at 90 F. Number Theoretical Trays, n = 5. Key Component = Propane. Propane Absorption Efficiency, Ea = 0.696. Propane Absorption Factor, A = 0.750.)

Calculation Steps →	1	2	3	4	5	6	7	8	9	10	11
	Inlet Feed Gas	Absorption Equilibrium Ratio	Absorption Factor	Absorption Efficiency	System L.O. Mole Fraction	Top Tray Equilibrium Ratio	Solute in L.O. Correc. Term	Absorbed Hydrocarbons	Residue Gas	System Lean Oil	Rich Oil
Component	Moles/T	K @ 300 psia. 110 F.	A	Ea	x	K @ 300 psia. 95 F.	Moles/T	Moles/T	Moles/T	Moles/T	Moles/T
Methane	6,391.00	14.000	0.0423	0.0423	.....	.....	.....	270.34	6,120.66	.....	270.34
Ethane	1,231.00	2.350	0.2521	0.2521	.....	.....	.....	310.34	920.66	.....	310.34
Propane	1,604.00	0.790	0.7500	0.6960	.....	0.700	.....	1,116.38	487.62	.....	1,116.38
i-Butane	145.00	0.355	1.6700	0.9670	.....	0.300	.....	140.22	4.78	.....	140.22
n-Butane	474.00	0.265	2.2400	0.9900	.....	0.230	.....	469.26	4.74	.....	469.26
i-Pentane	75.00	0.120	4.9400	1.0000	.....	0.097	.....	75.00	.....	.....	75.00
n-Pentane	58.00	0.090	6.5800	1.0000	.....	0.074	.....	58.00	.....	.....	58.00
Hexanes	16.00	0.033	17.9500	1.0000	.....	0.026	.....	16.00	.....	.....	16.00
Heptanes (+)	6.00	0.013	45.6000	1.0000	.....	0.010	.....	6.00	.....	.....	6.00
*Cut—450 F.	.....	.....	.....	.....	0.4891	0.000065	0.24	.....	0.24	1,694.12	1,693.88
*Cut—500 F.	.....	.....	.....	.....	0.4327	0.000013	0.04	.....	0.04	1,498.76	1,498.72
*Cut—550 F.	.....	.....	.....	.....	0.0782	0.000005	0.00	.....	0.00	270.86	270.86
Total	10,000.00 (G)	.....	.....	.....	1.0000	.....	.....	2,461.54	7,538.74 (G) (ΣY_o)	3,463.74 [L(1+ΣX_o)]	5,925.00 [L(1+ΣX_1)]
Notes on Method of Evaluation →	G Y_1	From K Value Nomograph[6]	$\frac{(AK)_{Key}\ C}{(K)_{other}\ C}$	$\frac{A^{n+1}-A}{A^{n+1}-1}$	From Table 5	K Nomograph[6] K Charts	$KxG\Sigma Y_o$ (Top Tray)	$E_aG(Y_1-Kx\Sigma Y_o) = G(Y_1-Y_o)$	G Y_o = (1)—(8)	Material Balance	$\frac{(G)}{(AK)_{Key}\ C}$
Pounds/T	257,217	.....	.....	.....	.....	.....	.....	.....	147,609	665,442	775,050
Gallons/T	.....	.....	.....	.....	.....	.....	.....	.....	.....	95,200	121,200
Mol. Weight	25.7	.....	.....	.....	.....	.....	.....	.....	19.6	.....	.....
Density, °API @ 60 F.	.....	.....	.....	.....	.....	.....	.....	.....	.....	37	53
Specific Heat	0.44	.....	.....	.....	.....	.....	.....	.....	0.43	0.48	0.52

12. **Sensible Heat Effect:** None. Average temperature of gas and liquid stream before absorption = 90 F.
13. **Top Tray Temperature Estimation:** Absorbed hydrocarbons lighter than the key Component = 13,636 lbs. Top tray temperature rise = [13,636 x 160] ÷ [147,609 x 0.43 + 665,442 x 0.48] = 6 F. Top tray temperature = 90 + 6 = 96 F. vs. 95 F. assumed.
14. **Bottom Tray Temperature Estimation:** Absorbed hydrocarbons heavier than key Component + key Component = 96,023 lbs. Bottom tray temperature rise = [96,023 x 160] ÷ [257,217 x 0.44 + 775,050 x 0.52] = 30 F. Bottom tray temperature = 90 + 30 = 120 F.
15. **Average Absorption Temperature:** [96 + 120] ÷ (2) = 108 F. vs. 110 F. assumed.

* Represents 50 F. apart normal boiling range cuts of absorption oil e.g. cut—450 F. represents a cut with a normal boiling range of 425 to 475 F.

TABLE 1—Final Calculations for Primary Absorber

(Basis: 10,000 Pound Moles Per Unit Time Inlet Gas at 300 psia and 90 F. Absorption Oil Inlet at 90 F. Number Theoretical Trays, n = 5. Key Component = Propane. Propane Absorption Efficiency, Ea = 0.696. Propane Absorption Factor, A = 0.750.)

Calculation Steps →	1	2	3	4	5	6	7	8	9	10	11
	Inlet Feed Gas	Absorption Equilibrium Ratio	Absorption Factor	Absorption Efficiency	System L.O. Mole Fraction	Top Tray Equilibrium Ratio	Solute in L.O. Correc. Term	Absorbed Hydrocarbons	Residue Gas	System Lean Oil	Rich Oil
Component	Moles/T	K @ 300 psia. 110 F.	A	Ea	x	K @ 300 psia. 95 F.	Moles/T	Moles/T	Moles/T	Moles/T	Moles/T
Methane	6,391.00	14.000	0.0423	0.0423	.....	.....	.....	270.34	6,120.66	.....	270.34
Ethane	1,231.00	2.350	0.2521	0.2521	.....	.....	.....	310.34	920.66	.....	310.34
Propane	1,604.00	0.790	0.7500	0.6960	0.00027	0.700	1.42	1,115.40	488.60	0.94	1,116.34
i-Butane	145.00	0.355	1.6700	0.9670	0.00027	0.300	0.61	139.63	5.37	0.94	140.57
n-Butane	474.00	0.265	2.2400	0.9900	0.00148	0.230	2.57	466.72	7.28	5.13	471.85
i-Pentane	75.00	0.120	4.9400	1.0000	0.00104	0.097	0.76	74.24	0.76	3.61	77.85
n-Pentane	58.00	0.090	6.5800	1.0000	0.00112	0.074	0.63	57.37	0.63	3.89	61.26
Hexanes	16.00	0.033	17.9500	1.0000	0.00099	0.026	0.19	15.81	0.19	3.43	19.24
Heptanes (+)	6.00	0.013	45.6000	1.0000	0.00086	0.010	0.07	5.93	0.07	2.98	8.91
*Cut—450 F.	.....	.....	.....	.....	0.48603	0.000065	0.24	.....	0.24	1,686.28	1,686.04
*Cut—500 F.	.....	.....	.....	.....	0.43018	0.000013	0.04	.....	0.04	1,492.51	1,492.47
*Cut—550 F.	.....	.....	.....	.....	0.07776	0.000005	0.00	.....	0.00	269.79	269.79
Total	10,000.00 (G)	.....	.....	.....	1.00000	.....	.....	2,455.78	7,544.50 (G) (ΣY_o)	3,469.50 [L(1+ΣX_o)]	5,925.00 [L(1+ΣX_1)]
Notes on Method of Evaluation →	G Y_1	From K Value Nomograph	$\frac{(AK)_{Key}\ C}{(K)_{other}\ C}$	$\frac{A^{n+1}-A}{A^{n+1}-1}$	Previous Stripper Calcu.	K Nomograph K Charts	$KxG\Sigma Y_o$ (Top Tray)	$E_aG(Y_1-Kx\Sigma Y_o)$ = $G(Y_1-Y_o)$	G_oY_o =(1)—(8)	Material Balance	$G(AK)_{Key}\ C$
Pounds/T	257,217	.....	.....	.....	.....	.....	.....	.....	147,957	664,067	772,327
Gallons/T	.....	.....	.....	.....	.....	.....	.....	.....	.....	95,100	120,900
Mol. Weight	25.7	.....	.....	.....	.....	.....	.....	.....	19.6	.....	.....
Density, °API @ 60 F.	.....	.....	.....	.....	.....	.....	.....	.....	.....	37	53
Specific Heat	0.44	.....	.....	.....	.....	.....	.....	.....	0.43	0.48	0.52

12. **Sensible Heat Effect.** None. Average temperature of gas and liquid stream before absorption = 90 F.
13. **Top Tray Temperature Estimation.** Absorbed hydrocarbons lighter than key Component = 13,636 lbs. Top tray temperature rise = [13,636 x 160] ÷ [147,957 x 0.43 + 664,067 x 0.48] = 6 F. Top tray temperature = 90 + 6 = 96 F. vs. 95 assumed.
14. **Bottom Tray Temperature Estimation.** Absorbed hydrocarbons heavier than key Component + key component = 95,675 lbs. Bottom tray temperature rise = [95,675 x 160] ÷ [257,217 x 0.44 + 773,327 x 0.52] = 30 F. Bottom tray temperature = 90 + 30 = 120 F.
15. **Average Absorption Temperature.** [96 + 120] ÷ (2) = 108 F. vs. 110 F. assumed.

* Represents 50 F. apart normal boiling range cuts of absorption oil, e.g. cut—450 F. represents a cut with normal boiling range of 425 to 475 F.

ature control setting.

5. Lean oil make-up requirement due to oil vaporization loss from absorbers.
6. Hydrocarbons material and energy loads for the various process equipment.

General Procedure of Design Method—It is seen from Figure 5 that under steady flow conditions, the incoming gas leaves the plant through three outgoing streams. These are the primary absorber residue, the reabsorber residue and the raw feed. It is also noted that the system absorption oil and the vapor stream off the raw feed tank are "recycle" streams. The quantity and compositions of these "recycle" streams affect the quantity and composition of all the outlet streams.

To determine the quantity and composition of the "recycle" streams, under steady flow conditions, it becomes necessary to repeat the absorption and stripping system design calculations, by using the values for the "recycle" streams from the previous to the subsequent calculations for about five times. At the end of this procedure, one will realize that the outlet streams and operating variables, such as lean oil rate, stripping steam rate, etc., are becoming approximately constant so far as the engineering accuracy is concerned. The plant hydrocarbon recovery as liquid in the raw feed is then calculated by subtracting the absorber residue stream values from that of the inlet gas. The last-go-around calculations are used to evaluate the material and energy loads for the various process equipment.

Absorption System Design Calculations—The absorber design calculations are based on solving the general absorption Equation (7).

The details of the procedure for making design calculations for the absorption system are given in Tables 1-A, 1, 2 and 3. Tables 1-A and 1 contain the results of first-go-around and final calculations for the primary absorber. Table 2 contains the final results of the flash-equilibrium calculations for the primary absorber rich oil when it is flashed to the reabsorber operating pressure. Table 3 contains the results of the final calculations for the reabsorber.

The purpose of including the first-go-around calculations for the primary absorber is twofold. First, it is the starting point in the process design calculations for the example presented herein. Second, its inclusion provides a quantitative and qualitative comparison between the absorber calculations with a solute free solvent and the one without a solute free solvent.

It will be noted that each table shows the sequence of calculation steps which was followed in preparing it. Each table also gives the description of the gas and liquid streams and the various terms of the general absorption equation. This is for the benefit of those who are not familiar with the nomenclature used in this article. In each table, notes on method of evaluating most of the calculation steps are also included.

After a sincere study of the design method and a little practice in using an automatic calculating machine, the reader will realize that hydrocarbon absorption design calculations are neither difficult to understand nor complicated to perform.

Although most of the calculation steps are self-explanatory, for a better understanding of the design procedure, explanation about some of the steps will be in order. As a starting point, Table 1-A, containing first-go-around calculations for the primary absorber is considered.

Step 1. This is obtained by converting the available plant inlet gas analysis to the basis of design calculations, viz., 10,000 pound moles per unit time.

Step 2. In this step, the equilibrium ratio values for the average absorption conditions are given. Equilibrium ratio value is dependent upon composition and type of components, pressure and temperature of the system. The equilibrium ratio values used in Step 2 are taken from the published litera-

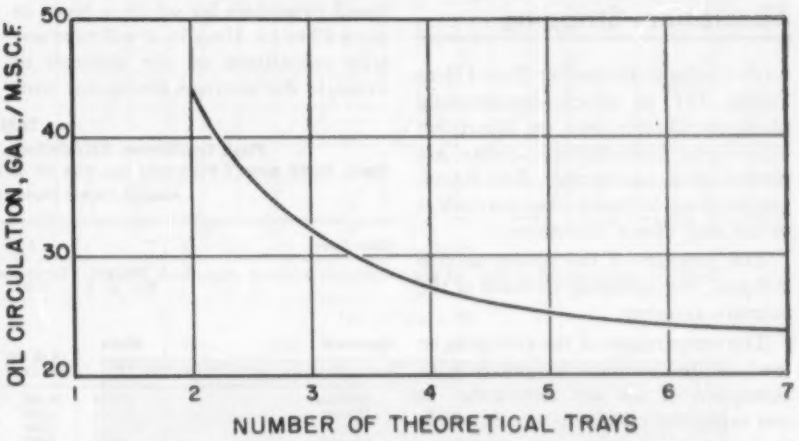

FIGURE 6—Effect of number of theoretical trays on absorption oil circulation (Basis: 70 percent propane absorption).

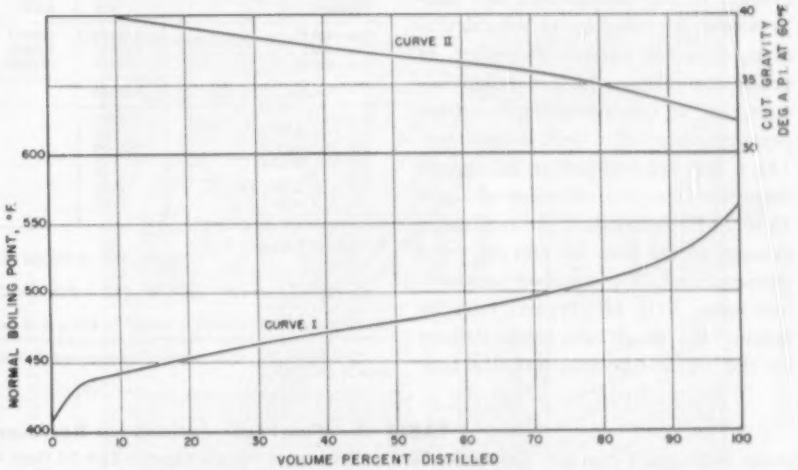

FIGURE 7—Curve I: Volume percent distilled vs. boiling point. Curve II: Volume percent distilled vs. cut gravity.

ture[6] (to be published in Part III as Figure 14) in which experimental phase-equilibrium data on absorption oil—light hydrocarbons system are plotted as a nomograph. The nomographic form is found very convenient to use and also a time-saver.

The pressure of the system used is 300 psia, the operating pressure of the primary absorber.

The temperature of the system to be used is the average temperature of absorption of the key component. It was explained previously in the article that the average absorption temperature to be used was the arithmetic average of top and bottom tray temperatures. At this stage of the calculations, it is not known. Therefore, in order to continue with the design calculations, an average absorption temperature value of 110 F. is assumed. (As a first approximation, assume an absorption temperature value of about 15 to 20 F. higher than the arithmetic average of the lean oil and inlet gas temperature). The assumed temperature value is to be checked later by making the temperature calculations for the top and bottom tray, the proposed procedure for which is given in steps 12 to 15. Usually, it will take one trial calculation of the absorber to evaluate the average absorption temperature value.

To sum up, in Step 2 equilibrium ratio values for various components are obtained from K-value nomo-

TABLE 2

Flash Equilibrium Calculations for Primary Absorber Rich Oil

(Basis: 10,000 moles/T Plant Inlet Gas, Rich Oil at 300 psia and 120 F. Flashed to 100 psia and 115 F. Assumed Flashed Liquid to Vapor Ratio, $\frac{l}{v} = 8.90$)

Calcs. Steps →	1	2	3	4	5	6
	Primary Rich Oil, Z	Equilibrium Ratio			Flashed Vapor, v	Flashed Liquid, l
Component	Moles/T	K @ 100 psia 115 F.	KZ	$K+\frac{l}{v}$	$\frac{KZ}{K+\frac{l}{v}}$ = Moles/T	Moles/T
Methane	270.34	38.500	10,408.09	47.400	219.57	50.77
Ethane	310.34	6.000	1,862.04	14.900	124.97	185.37
Propane	1,116.34	2.000	2,232.68	10.900	204.83	911.51
i-Butane	140.57	0.900	126.51	9.800	12.91	127.66
n-Butane	471.85	0.660	311.42	9.560	32.58	439.27
i-Pentane	77.85	0.290	22.58	9.190	2.46	75.39
n-Pentane	61.26	0.225	13.78	9.125	1.51	59.75
Hexanes	19.24	0.080	1.54	8.980	0.17	19.07
Heptanes (+)	8.91	0.030	0.27	8.930	0.03	8.88
*Cut—450 F.	1,686.04	0.00017	0.29	8.90017	0.03	1,686.01
*Cut—500 F.	1,492.47	0.00005	0.08	8.90005	0.01	1,492.46
*Cut—550 F.	269.79	0.00002	0.00	8.90002	0.00	269.79
Total	5,925.00	.....	.....	.....	599.07	5,325.93
Pounds/T	773,327	.....	.....	.....	19,224	754,103
HC, Pounds/T	110,837	.....	.....	.....	19,217	91,620
L.O., Pounds/T	662,490	.....	.....	.....	7	662,483
HC, Mol. Weight	44.8	.....	.....	.....	32.1	48.8
L.O., °API	37	.....	.....	.....	.....	37
HC, △ H = Btu./Lb.	107.0	.....	.....	.....	237	105
LO., △ H = Btu./Lb.	152.5	.....	.....	.....	237	150

7. Enthalpy Balance:
Input = $\frac{(110{,}837 \times 107.0) + (662{,}490 \times 152.5)}{T} = 112.9$ MM Btu.
Output = $\frac{(19{,}224 \times 237) + (91{,}620 \times 105) + (662{,}483 \times 150)}{T} = 113.6$ MM Btu.

8. Calculated l/v = (5,325.93) ÷ (599.07) = 8.89 vs. 8.90 assumed.

* Represents 50 F. apart normal boiling range cuts of absorption oil, e.g. Cut—450 F. represents a cut with normal boiling range of 425 to 475 F.

TABLE 3—Final Calculations for Reabsorber

(Basis: 10,000 Mol/T Plant Inlet Gas. Reabsorber Feed Consists of Primary Absorber Rich Oil Flash Vapor at 115 F. and Recycle Vapor from Raw Feed Tank at 90 F. Composite Feed at 95 F. and 100 psia. Absorption Oil Inlet at 90 F. Number Theoretical Trays, n = 5. Key Component = Propane. Propane Absorption Efficiency, Ea. = 0.696. Propane Absorption Factor, A = 0.750.)

Calculation Steps →	1	2	3	4	5	6	7	8	9	10	11
	Reabsorber Feed Gas	Absorption Equilibrium Ratio	Absorption Factor	Absorption Efficiency	System L.O. Mole Fraction	Top Tray Equilibrium Ratio	Solute in L.O. Correc. Term.	Absorbed Hydrocarbons	Residue Gas	System Lean Oil	Rich Oil
Component	Moles/T	K @ 100 psia 110 F.	A	Ea	x	K @ 100 psia 95 F.	Moles/T	Moles/T	Moles/T	Moles/T	Moles/T
Methane	278.90	38.000	0.0375	0.0375	.....	.....	.....	10.46	268.44	.....	10.46
Ethane	359.22	5.800	0.2457	0.2457	.....	.....	.....	88.26	270.96	.....	88.26
Propane	1,410.88	1.900	0.7500	0.6960	0.00027	1.600	0.42	981.68	429.20	0.55	982.23
i-Butane	115.12	0.840	1.7000	0.9690	0.00027	0.680	0.18	111.38	3.74	0.55	111.93
n-Butane	286.17	0.620	2.3000	0.9920	0.00148	0.500	0.72	283.17	3.00	3.01	286.18
i-Pentane	19.77	0.270	5.3000	1.0000	0.00104	0.210	0.21	19.56	0.21	2.11	21.67
n-Pentane	11.55	0.210	7.0000	1.0000	0.00112	0.160	0.18	11.37	0.18	2.28	13.65
Hexanes	1.10	0.072	19.8000	1.0000	0.00099	0.054	0.05	1.05	0.05	2.01	3.06
Heptanes (+)	0.16	0.027	52.8000	1.0000	0.00086	0.020	0.02	0.14	0.02	1.74	1.88
*Cut—450 F.	0.03	.....	.....	.....	0.48603	0.000090	0.04	.....	0.04	987.17	987.16
*Cut—500 F.	0.01	.....	.....	.....	0.43018	0.000020	0.01	.....	0.01	873.73	873.73
*Cut—550 F.	0.00	.....	.....	.....	0.07776	0.000007	0.00	.....	0.00	157.94	157.94
Total	2,482.91 (G)	.....	.....	.....	1.00000	.....	.....	1,507.07	975.85 (G) (ΣY_o)	2,031.09 [L(1+ΣX_o)]	3,538.15 [L(1+ΣX_1)]
Notes on Method of Evaluation →	GY1	From K Value Nomograph[6]	$\frac{(AK)_{Ka}\ C}{(K)_{ether}\ C}$	$\frac{A^{n+1}-A}{A^{n+1}-1}$	Previous Stripper Calcs.	K Nomograph[6] K Charts	$K_2G\Sigma Y_o$ (Top Tray)	$\frac{E_aG(Y_1-K_2\Sigma Y_o)}{G(Y_2-Y_o)}$ =	G Y_o = (1)—(8)	Material Balance	G $(AK)_{Ka}$ C
Pounds/T	102,966	.....	.....	.....	.....	.....	.....	.....	31,743	388,753	459,977
Gallons/T	.....	.....	.....	.....	.....	.....	.....	.....	.....	55,700	72,000
Mol. Weight	41.5	.....	.....	.....	.....	.....	.....	.....	32.5	.....	.....
Density, °API @ 60 F.	.....	.....	.....	.....	.....	.....	.....	.....	.....	37	53
Specific Heat	0.42	.....	.....	.....	.....	.....	.....	.....	—0.41	0.48	0.52

12. Sensible Heat Effect: (102,966) (95-t) (0.42) = (388,753) (t-90) (0.48) t = 91 F. = Average temperature of gas and liquid stream before absorption.
13. Top Tray Temperature Estimation: Absorbed hydrocarbons lighter than key component = 2,815 lbs. Top tray temperature rise = [2,815 x 160] ÷ [31,743 x 0.41 + 388,753 x 0.48] = 2 F. Top tray temperature = 91 + 2 = 93 F. vs. 95 F. assumed.
14. Bottom Tray Temperature Estimation: Absorbed hydrocarbons heavier than key component + key component = 68,409 lbs. Bottom tray temperature rise = [68,409 x 160] ÷ [102,966 x 0.42 + 459,977 x 0.52] = 39 F. Bottom tray temperature = 91 + 39 = 130 F.
15. Average Absorption Temperature: [93 + 130] ÷ (2) = 111.5 F. vs. 110 F. assumed.

* Represents 50 F. apart normal boiling range cuts of absorption oil, e.g. Cut—450 F. represents a cut with normal boiling range of 425 to 475 F.

graph[6] at 300 psia and 110 F., an assumed absorption temperature value; the assumed temperature value to be checked later on by calculating top and bottom tray temperatures.

Step 3. Here the values of absorption factor A for the various components are evaluated in the following manner.

First, the absorption efficiency, Ea of propane is assumed equal to 0.696, which is a value slightly greater than 0.695, the fraction of propane to be absorbed by the solvent according to the given design condition of the primary absorber.

Second, it is assumed that the absorber will contain five theoretical trays, i.e., n = 5.

The reason for making the above assumption can be explained by examining Figure 6, in which calculated lean oil circulation rate is plotted against number of theoretical trays for a constant absorption duty. The lean oil circulation rate decreases as the number of theoretical trays is increased; however, beyond five theoretical trays, the decrease in the lean oil circulation rate is rather small. For calculations of engineering accuracy, the assumption of five theoretical trays is therefore sufficient to obtain an answer slightly on the conservative side.

The number of actual trays corresponding to five theoretical trays will be dependent on the type of tray used and also on the tray efficiency obtainable under a given set of operating conditions. The discussion of types of trays and the various factors which affect their tray efficiencies is beyond the scope of this article. In the author's opinion, for an absorber equipped with bubble-cap trays, normally about twenty-five actual trays will correspond to five theoretical trays.

TABLE 4
New Absorption Oil ASTM Distillation Results and Physical Properties

Volume Distilled Percent	Normal Boiling Point, F.	Cut Distillation Range	Cut Gravity °API @ 60 F.
Initial	408	.....	....
5	435	.....	....
10	442	0 to 20%	40.0
20	453	.....	....
30	463	20 to 40%	38.4
40	470	.....	....
50	477	40 to 60%	37.0
60	486	.....	....
70	495	60 to 80%	35.9
80	508	.....	....
90	525	80 to 100%	33.8
95	540	.....	....
End Point	546	.....	....
Recovery	97.5 percent	.....	....
Residue	2.5 percent	.....	....
Gravity Absorption Oil, °API @ 60 F.			37
Molecular Weight			192
Viscosity @ 100 F., centipoises			2
Characterization Factor			11.7

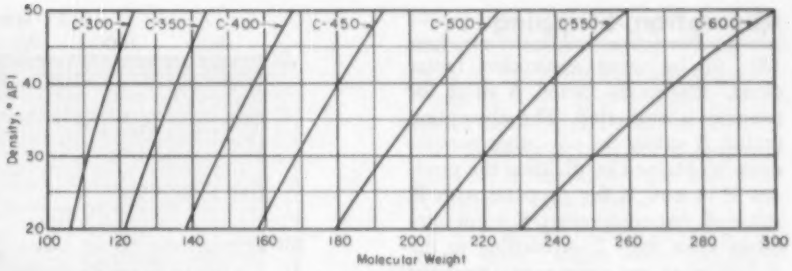

FIGURE 8—Density versus molecular weight for various boiling range fractions.

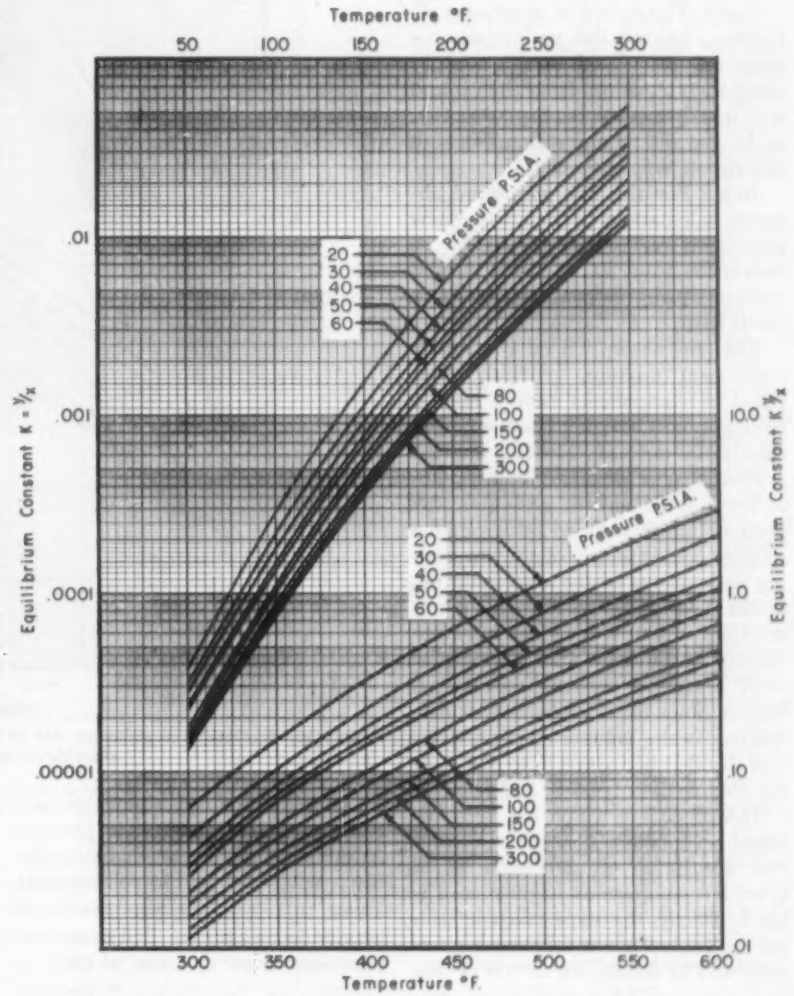

FIGURE 9—Equilibrium constants for 425 to 475 F. normal boiling range fraction (Average characterization factor, 11.5).

By using propane absorption efficiency, Ea = 0.696 and n = 5, the value of absorption factor A for propane is obtained either by solving Equation (8) or by the use of absorption factor vs. absorption efficiency chart[7] (to be published in Part III, as Figure 13). The absorption factor, A value for any other component is calculated by dividing the product of A and K for propane with K value of that component from Step 2. Propane is termed as the key component because its A value is closest to unity. To summarize, in Step 3, propane absorption efficiency Ea = 0.696, a value slightly greater than 0.695, the fraction of propane to be absorbed, is assumed. Then by solving Equation

(8), or by using absorption factor chart,[7] absorption factor, A value for propane is evaluated. The absorption factor, A values for any other component, is obtained by dividing the product of A and K for propane with K value of that component, K values are taken from Step 2. According to the definition of key component, propane is termed as the key component.

Step 4. The values of absorption efficiency, Ea for the various components are calculated in this step by using their A values from Step 3 and n = 5 and then solving Equation (8), or by the use of absorption factor vs absorption efficiency chart.[7]

Step 5. For the first go-around absorber calculations in Step 5, the new absorption oil is represented by its conversion into 50 F. apart normal boiling range cut-components on a molal basis.

The new absorption oil is a multicomponent mixture, generally composed of components having normal boiling points ranging from approximately 400 to 550 F. The fact that the portion that is vaporized into the absorber residue stream and also, the portion that is stripped out from the stripper consist mostly of the low boiling components of the absorption oil, makes it advisable to convert the absorption oil into 50 F. apart cut-components. Arbitrarily, the volume percent distilled between the normal boiling range of 425 to 475 F. is designated as the volume of cut-450 F.; that distilled between 475 to 525 F. as the volume of cut-500 F. and so on.

The procedure which has been followed in making the conversion of new absorption oil into such 50 F. apart cut-components is given in Table 5. Briefly, the steps taken in preparing Table 5 are as follows: A modified ASTM distillation of 200 or 300 cc. sample of the new absorption oil is run at normal atmospheric pressure. In addition, during the same distillation, each 20 per cent by volume distillation cuts are kept separate for its gravity determination. The gravity determinations are corrected to 60 F.

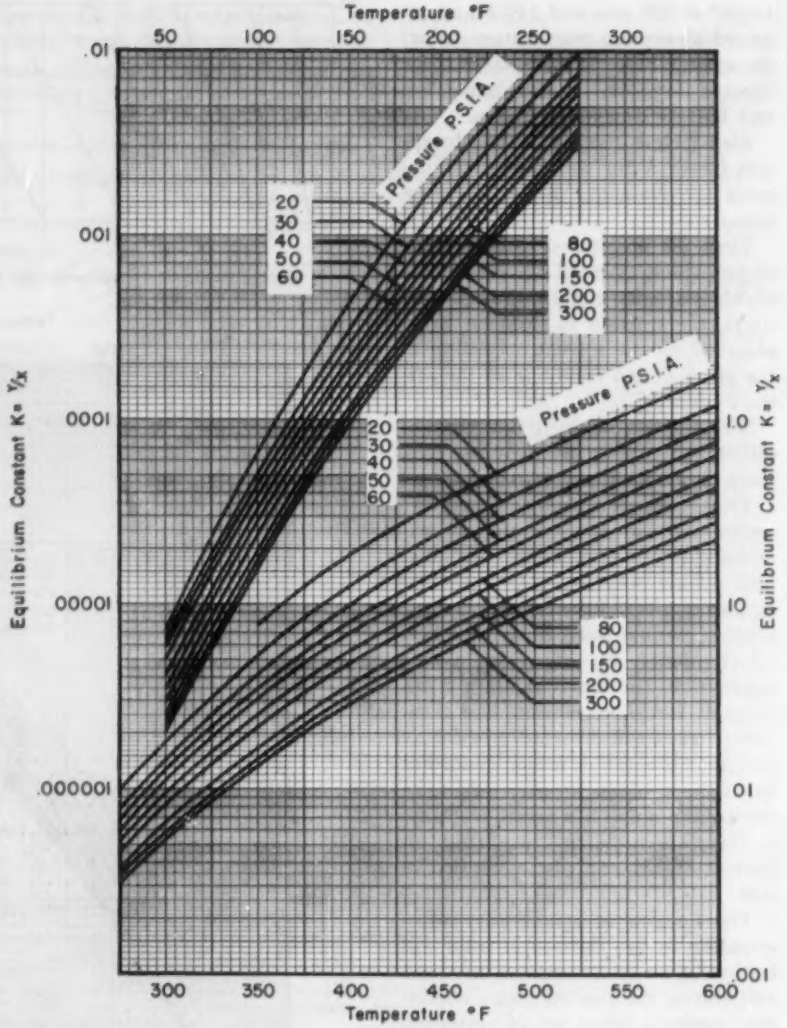

FIGURE 10—Equilibrium constants for 475 to 525 F. normal boiling range fraction (Average characterization factor, 11.5).

The above experimental data are then plotted as shown in Figure 7; Curve I of Figure 7 represents the results of ASTM distillation, while Curve II of Figure 7 represents the gravity determinations of 20 percent cuts. From Curve I of Figure 7, the volume precent distilled for 50 F. apart normal boiling range cuts are obtained. From Curve II of Figure 7, the average gravity of the above cuts are obtained. By use of the conversion factors and Figure 8, in which density vs molecular weight for various boiling range fractions are given, the new absorption oil is converted into cuts of average normal boiling points 50 F. apart on a molal basis.

Whenever the experimental results for gravity on 20 percent cuts of ASTM distillation are not available, it is recommended that as an approxi-

TABLE 5

Calculations for New Absorption Oil Conversion Into 50 F. Apart Normal Boiling Range Cut-Components on Molal Basis

(Basis: 100 Gallons New Absorption Oil)

Calculation Steps→	1	2	3	4	5	6	7	8
Component	Normal Boiling Ranges, F.	Volume Distilled Percent	Cut Gravity °API at 60 F.	Lbs./Gal.	Lbs.	Mol. Weight	Moles	Mole Fraction
Cut—450 F.	425 to 475	46	39	6.91	318	179	1.777	0.4891
Cut—500 F.	475 to 525	45	36	7.08	316	201	1.572	0.4327
Cut—550 F.	525 to 575	9	33	7.16	64	225	0.284	0.0782
Total	.....	100	...	....	698	....	3.633	1.0000
Notes on Method of Evaluation→	Arbitary Definition	Figure 7	Figure 7	Conversion Factor	(3) x (4)	Figure 8	(5) ÷ (6)	.....

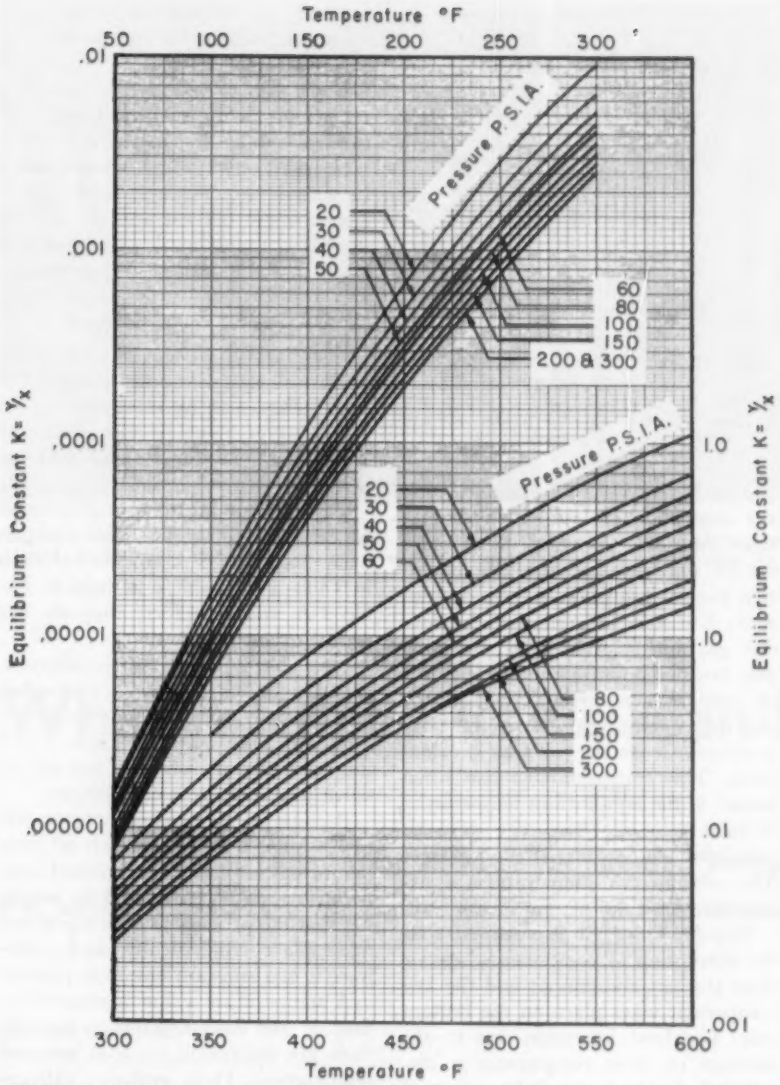

FIGURE 11—Equilibrium constants for 525 to 575 F. normal boiling range fraction (Average characterization factor, 11.5).

mation, the characterization factor value, $\sqrt[3]{\text{boiling point °R}} \div$ sp. gravity of the absorption oil be used to obtain the gravity of 50 F. apart cuts. In the first go-around absorber calculations, the new absorption oil generally does not contain any solute. However, afterwards, depending upon the extent of stripping performed by the stripping system, the system absorption oil is likely to contain some of the solutes in varying amounts. Therefore, after the first go-around calculations, Step 5 is obtained by using the previously calculated composition of system lean oil leaving the stripper bottom.

Step 6. In this step, equilibrium ratio values for the top tray operating conditions are given. Since the top tray temperature is not known, in order to continue with the design calculations, its value 5 or 10 F. higher than the inlet absorption oil temperature is assumed. This assumption is later on checked by the top tray temperature calculation as given in Steps 12 and 13.

By assuming the top tray temperature equal to 95 F., and by using 300 psia as the system pressure, equilibrium ratio values for the light hydrocarbons are obtained from K-value nomograph.[6]

For high boiling hydrocarbons, K-charts on the basis of various 50 F. apart normal boiling range fractions for an average characterization factor of 11.5 have been prepared but only three parameters are presented here as Figures 9, 10, 11.

Since the absorption oil was converted into 50 F. apart cuts in Step 5 and the characterization factors of most of the absorption oils range between 11 and 12, presentation of K-values for a characterization factor of 11.5 provides a convenient means of their use in the absorption and stripping design calculations.

In preparing Figures 9 to 11, published data,[8] which were calculated from experimentally determined fugacity values, and the interpolation and extrapolation of these data by log K vs reciprocal of the absolute temperature plots have been used. Since the absorption oil of the example contains Cut-450 F., Cut-500 F. and Cut-550 R., Figures 9, 10 and 11 are used to obtain their K-values at 300 psia and 95 F.

Step 7. The correction terms for the presence of solute in the system lean oil are evaluated in this step.

The correction term for any component is obtained by multiplying its mole fraction in the solvent, (Step 5) with its K value (Step 6) for top tray operating conditions, and the total number of moles of the residue gas. The total number of moles of residue gas is closely approximated by using absorption efficiency Ea (Step 4) as the fraction absorbed for the various components.

For the first-go-around calculations, since the new absorption oil does not contain any solute, the correction term values in Step 7 are zero. However, after the first-go-around calculations the solvent is likely to contain solute and therefore Step 7 will require to be evaluated. The values of term (x) (K) (GΣYo) for the cut-components of the absorption oil are used to approximate the absorption oil vaporization loss into the residue gas. This gives the oil vaporization loss slightly on the conservative side. Theoretically speaking, in order to calculate absorption oil vaporization loss, it can be assumed that the residue gas leaving the top tray will be in equilibrium with the top tray liquid. Therefore, the correct values of mole fraction of absorption oil cut-components to be used in the calculation are those in the liquid leaving the top tray and not those in the liquid entering the top tray. Due to the absorption of the light hydrocarbons on the top tray, mole fraction of cut-components in the top tray liquid becomes smaller than that in the liquid entering the top tray.

Step 8. Here the quantity of hydro-

carbons absorbed by the system lean oil is evaluated.

The quantity of any component absorbed is obtained by subtracting its "solute in lean oil correction term" (Step 7) from its quantity in the inlet gas (Step 1) and then multiplying the resulting difference with its absorption efficiency, Ea (Step 4).

Step 9. In this step, the quantity of hydrocarbons leaving the absorber in the residue gas is given. For any component, it is obtained by subtracting the quantity absorbed for that component (Step 8) from its quantity in the inlet gas (Step 1).

Step 10. Here, the quantity of system lean oil is evaluated. The total quantity of the system lean oil is first obtained by making an overall material balance. Inlet gas plus system lean oil = residue gas plus rich oil. The total quantity of rich oil is given by the product of total inlet gas (G), absorption factor, A of the key-component (Step 3) and K-value of the key component (Step 2). After the total quantity of system lean oil is thus determined, by multiplying it with the mole fraction of various components in system lean oil (Step 5), the quantity of various components in system lean oil is obtained.

Step 11. In this step, the quantity of various components in the rich oil is calculated by making a material balance on a component basis.

Temperature Change Due to Absorption—The temperature rise calculations for an absorber are somewhat complicated because of the fact that in most of the absorbers, in addition to hydrocarbons, mass transfer of water between gas and liquid stream takes place. Also, there is heat transfer to the surroundings due to radiation and convection.

An empirical method for calculating temperature changes in an absorber is proposed herein and it is to be considered as an approximation only.

Step 12. According to this method, it is first assumed that sensible heat effect takes place between the inlet gas and system lean oil. Whenever, the inlet gas temperature and the inlet lean oil temperature are different, by sensible heat effect, an equilibrium temperature for the gas and liquid stream is first calculated.

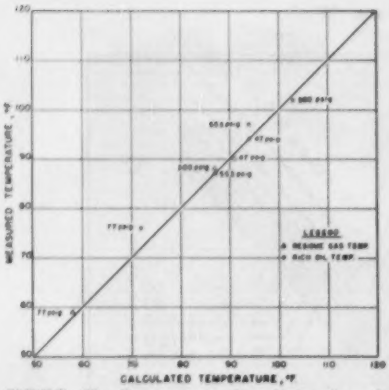

FIGURE 12—Comparison of calculated and measured values of absorber residue gas and rich oil streams.

Step 13. Second, it is assumed that the absorption of components lighter than the key component takes place on the top tray; and the heat liberation due to absorption of these components is distributed amongst the residue gas and inlet lean oil. By using 160 Btu per pound as the latent heat of condensation, irrespective of the absorber operating pressure, the temperature rise on the top tray is calculated. This temperature rise when added to the equilibrium temperature of inlet lean oil (Step 12) gives an estimated temperature of the top tray. The residue gas temperature is assumed to be equal to that of top tray.

Step 14. Third, it is assumed that the absorption of components heavier than the key component and the key component takes place on the bottom tray. The heat liberation due to absorption of these components is distributed amongst the inlet gas and rich oil. Irrespective of the absorber operating pressure, by using 160 Btu per pound as latent heat of condensation, the temperature rise on the bottom tray is calculated. This temperature rise when added to the equilibrium temperature of inlet gas (Step 12) gives an estimated temperature of the bottom tray, or the rich oil temperature.

A comparison between the calculated temperature values by the above empirical method and the measured temperature values obtained from the actual operation of four absorbers is shown in Figure 12. In preparing Figure 12, with one exception published absorber performance test data[9,10,11] have been used.

The author has found one limitation to the above empirical method where the agreement between the calculated and measured temperature values is rather poor. It is in the case of absorber operations in which the ratio of lean oil to the inlet gas on a weight basis is approximately less than two. It is believed that in such cases the thermal effect due to mass transfer of water between gas and liquid stream might become appreciable and therefore, unless some allowance was made for this effect, the agreement between calculated and measured temperature values could be poor.

For removal of heat of absorption, if an absorber were to be equipped with side-coolers or inter-coolers, the procedure of Steps 12 and 13 can be used to estimate the size and the location of these coolers.

Table 1 contains the fifth-go-around or the final calculations for the primary absorber. The calculation steps in Table 1 are similar to those in Table 1-A and therefore, they do not need further explanation.

In Table 2, final flash equilibrium calculations for the primary absorber rich oil are given. The calculation steps are also shown in Table 2 and they are easy to follow. They do involve trial and error calculations.

Because of its expansion from 300 to 100 psia, the primary rich oil temperature is lowered. The lowered temperature value is calculated by assuming that the primary rich oil expansion takes place adiabatically, and therefore, it is a constant enthalpy process.

A temperature value is assumed in Step 2; and flash equilibrium calculations are completed for that assumed temperature. Then, enthalpy calculations for the primary rich oil before and after the expansion are made. If the enthalpy values before and after the expansion are found to be approximately constant then the assumed temperature in Step 2 is considered as the correct temperature.

Table 3 contains the final calculations for the reabsorber. The procedure used in preparing this table is similar to that described for the primary absorber and therefore no further explanation is given.

End of Part 2. Part 3 will appear in an early issue.

SPECIAL NOTE

Readers who wish copies of K-charts for cut components Cut-300F, Cut-350F, Cut-400F and Cut-600F for 50 to 600 F. temperature range and 20 to 300 psia pressure range, and also of K-charts for cut components Cut-300F through Cut-600F for 50 to 200 F. temperature range and 400 to 1000 psia pressure range, may arrange to obtain them by writing to the author, c/o Magnolia Petroleum Company, Dallas, Texas. Because of space limitations, they are not included with this article.

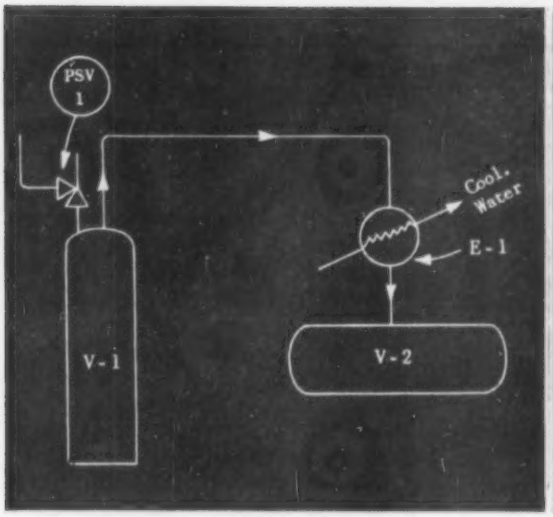

FIGURE 1—Interconnected equipment in which the parts cannot be isolated. To be treated as one unit and protected by one relief valve.

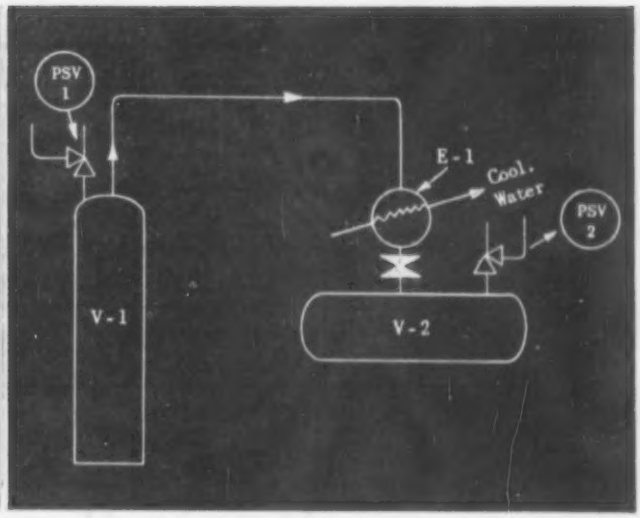

FIGURE 2—Interconnected equipment in which the parts can be isolated by a block valve. To be treated as two units with each unit protected by a relief valve.

What a Relief Valve Can Do

Sound engineering dictates the use and location of relief valves and proves the payout in safety to personnel and plant as well as dollar savings.

Joseph Conison,
The Fluor Corporation, Ltd., Los Angeles

A "MUST" IN ALL chemical processing and power plants is the proper use and selection of relief valves, as well as the complete coverage of hazardous conditions involving the use of relief valves. By means of relief valves, equipment is protected from rupture; fire hazards are reduced; safety to personnel is increased; and, continuous plant operation is assured.

The importance of relief valves to the public welfare has grown to such an extent that all cities, counties, states and federal government have specific relief valve codes that are strenuously enforced and regulated. In many cases, plants are forbidden to start up because of not adhering satisfactorily or completely to a relief valve code governing that particular locality.

Relief valves in general are discussed in the 1951 API-ASME and the 1952 ASME "Unfired Pressure Vessel Codes." Mentioned as causes for over-pressure are fires, or other unexpected sources of heat. However, to properly diagnose a need for a relief valve, safety engineers should consider over-pressure due not only to the above causes, but also to: (1) process variations, (2) abnormal process operation, and (3) equipment failure.

Fire—Fire is listed first, and is also number one in the minds of safety engineers in petroleum refineries and chemical plants because it is more prevalent and devastating.

If equipment containing liquid is exposed to fire, then it is possible for the heat from the fire to vaporize the liquid. The pressure developed in the vessel will be a function of the temperature and composition of the liquid-vapor state. One way to keep the pressure down is to provide an escape for the vapors generated. If no provision is made to allow the vapors to escape, then by the simple rules of physical chemistry, it is possible to develop excessive pressure beyond the rupture point of the equipment. The types of equipment to consider that can be exposed to fire are heat exchangers, fractionating columns, storage vessels and operating vessels.

In general, when applying relief valves, equiment that may be connected together by a system of adequate piping not containing valves which can isolate any item may be considered as one unit in requiring a relief valve or valves. If the items can be separated from one another by

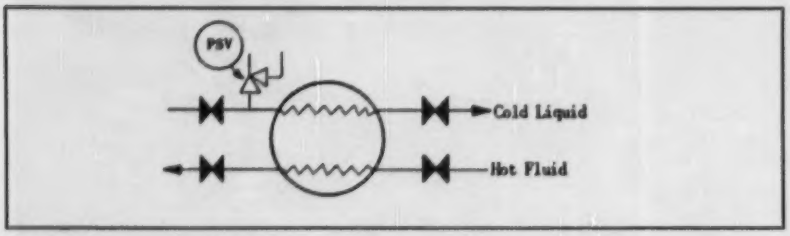

FIGURE 3a—Heat exchanger protected on cold side.

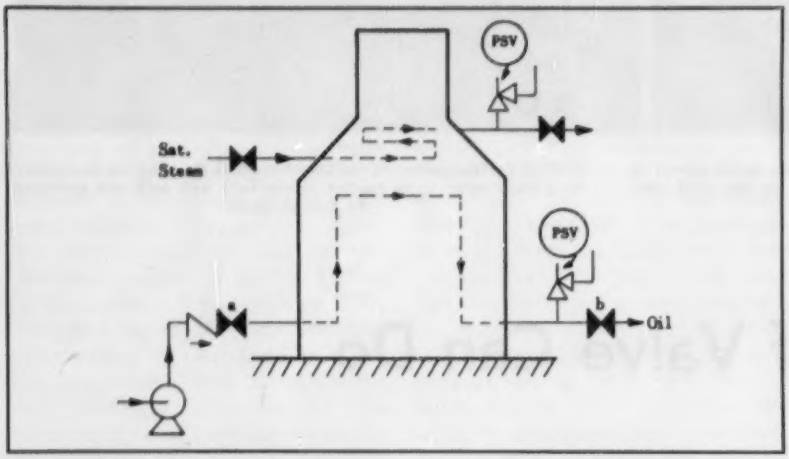

FIGURE 3b—Fired tubular heater protected by relief valves on tube side.

valves in the connecting piping, then each item shall be considered as a unit with its own individual relief valve or valves. As an example, in Figure 1, the items are not separated by valves; therefore, PSV-1 can be used to protect V-1, V-2 and E-1. In Figure 2, V-1 and E-1 are separated from V-2 by a valve; therefore, PSV-1 can be sized to relieve V-1 and E-1, and PSV-2 sized to relieve V-2.

Blocked Outlets and Inlets—Liquid filled lines that can be blocked in and are also exposed to the sun should be protected by relief valves. The sun beating down on bare pipe can heat the entrapped liquid, causing expansion of the liquid, which can create enough pressure to easily rupture the piping.

If the cold side of a heat exchanger is liquid filled and can be blocked, then the cold side requires a relief valve. Referring to Figure 3a, it is quite possible to close the block valves on the cold side of the heat exchanger and at the same time have hot liquid go through on the "hot" side. In a case such as this, the "hot" side can transmit heat to the "cold" side, expand the blocked-in liquid, and can easily rupture the shell or tubes.

A fired-tube heater with liquid oil in the coils, and when the coils can be blocked in, requires relief protection. In Figure 3b, the heater can very easily have the coils blocked in and heat applied at the same time. The coils can be blocked in by closing the two block valves "a" and "b"; or by closing the outlet block valve and the check-valve preventing any reverse flow; or by having the outlet block valve closed and the pump pumping liquid through the relief valve. Because of the possibility of the latter conditions taking place, it is preferred that the relief valve be placed on the coil outlet side to permit flow through the coils and thus prevent coking.

In Figure 3b, it is very possible to start up the heater with the valves on the steam coils closed and liquid condensed in the coils. In view of this possibility, it is necessary to insert a relief valve on the super-heater steam coil. A city inspector in a large city once refused to permit a plant from starting up until a relief valve was inserted for just such an application. By citing this incidence one can readily appreciate the importance of, let us say, the lack of relief valves.

Blocked Outlets—Block outlets can apply to: (1) reciprocating compressors, (2) reciprocating pumps, (3) gear pumps, (4) steam exhaust side of turbines, and (5) fractionating columns.

In the first three cases above, we have constant displacement equipment. In other words, the units are discharging constant volume liquid, gas or vapor. If the discharge is blocked, the units are so designed that the fluid cannot reverse itself but must go forward with the motion of the piston or gear. If it cannot go forward, then the unit will either stall or rupture the case or associated piping. Therefore, to protect the equipment, relief valves are installed for just such a contingency. The reference in Figure 4 illustrates typical relief valve arrangements. In Cases A and B, the relief valves may discharge to the suction side of the units.

Figure 4c refers to a turbine driven

Meet the Author

JOSEPH CONISON, senior instrument engineer for The Fluor Corporation, Ltd., is responsible for selecting process instrumentation for use in refineries and chemical power plants. In addition to writing specifications and buying control instrument, Conison supervises junior instrument engineers in their training program at Fluor. Associated with the engineering firm since 1947, he previously had been connected with construction and start-up of an ethylalcohol plant. He also handled process and project engineering; held supervisory posts in aluminum and magnesium foundries; been in charge of research and development in bituminous plastics, and served as an analytic chemist. Conison is a chemical engineering graduate from the University of Cincinnati.

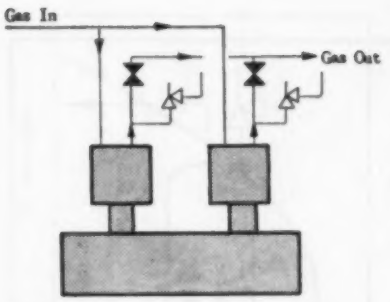

FIGURE 4a—Reciprocating compressor protected on the discharge side.

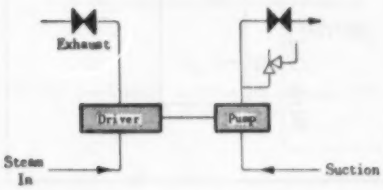

FIGURE 4b—Reciprocating pump or gear pump protected on the discharge side.

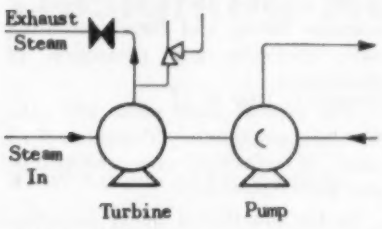

FIGURE 4c—Turbine driver protected on the exhaust side.

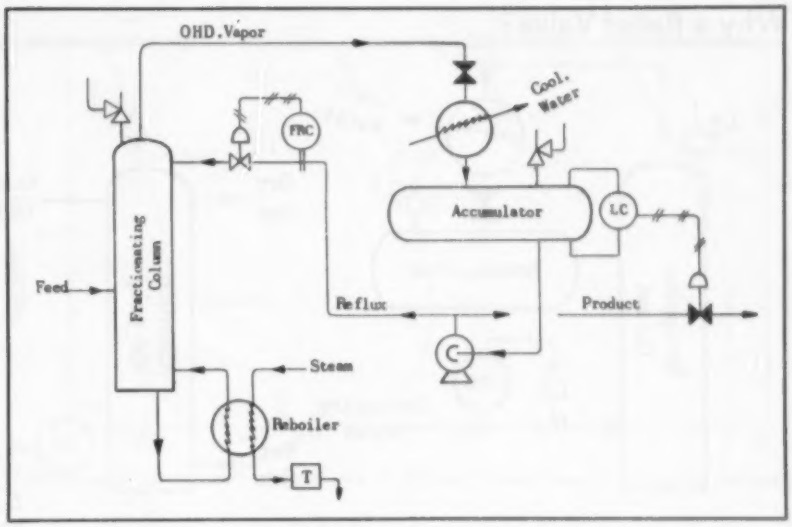

FIGURE 5—Typical fractionating unit.

pump with a relief valve on the steam exhaust side of the turbine. The reason for this arrangement is that the exhaust side of a turbine is invariably designed for a much lower pressure than the inlet side. If the inlet side of the turbine were to be open and the outlet side blocked, then the exhaust pressure would be the same as the inlet. It is for just such an emergency that relief valves are installed.

Over pressure can also be developed in fractionating columns when the overhead vapors are blocked and the source of heat to the column continues. In Figure 5, assume the block valve in the overhead vapor line is accidentally closed and heat continues to the column. This condition can produce overpressure and necessitates the use of a relief valve on the column.

Reflux Failure—Referring to Figure 5 again, the loss of reflux can also cause overpressure to the column. Reflux acts as a coolant to the column, so the effect of its loss is readily evident. Reflux failure may be due to pump failure, instrument failure, or loss of cooling water.

Instrument Failure—Another important feature to guard against is instrument failure. Instrument failure can be attributed to the possibility of the instrument itself failing, or the loss of instrument air to one or all the instruments.

One commonly considered instrument failure possibility is a control valve "freezing" in an open or closed position. Supposing, in Figure 6a, that the stripping to the column is at 135 psig, the maximum design of the column is 50 psig, and the control valve, FRCV, freezes in an open position. If the overhead condenser is not designed to condense the full capacity of the steam through the control valve, or if the block valve between the condenser and the accumulator is closed, then it is possible to overpressure the column with 135 psig steam.

Entrance of a fluid or vapor from a high pressure system to a low pressure system may sometimes be a source of equipment overpressure. In Figure 6b, the absorption of the wet gas by lean oil takes place at 450 psig. The rich oil leaves the absorber through a level-control valve to the de-ethanizing column, which operates at 200 psig and has a maximum design of 250 psig. The only thing that separates the absorber from the de-ethanizer is the control valve which reduces the pressure (as well as controls the level) down to the operating pressure in the de-ethanizer. If the control valve were to freeze in an open position, then it is possible to feed an excess of high pressure liquid and gas to the de-ethanizer. If the de-ethanizer is not designed to handle this high rate, then relief protection must be provided.

Other possibilities to consider as the basis of instrument failure are: (1) Steam or hot oil control to a reboiler, (2) cooling water control on a condenser or cooler, (3) steam control to a turbine, (4) pressure control on a fractionating column, and (5) steam boiler controls.

Abnormal Process Operation—Abnormal process operation also has to be considered in the application of relief valves. The human element is just as cognizant a factor as equipment elements.

Some examples are: in Figure 3a, manually shutting off of the block valves on the cold side of the exchanger and opening the block valves on the hot side; in Figure 3b, manually shutting off of the block valves on the steam coil containing water, and keeping the heater fired up; manually shutting off discharge valves on the compressor and pump in Figure 4a and 5. These examples are just a few of the cases in which it is possible that manual operation can cause overpressure of equipment, and in all cases must be considered for sizing relief valves.

Equipment Failure—Plant cooling water pump failure, fractionating column reflux pump failure, and tube

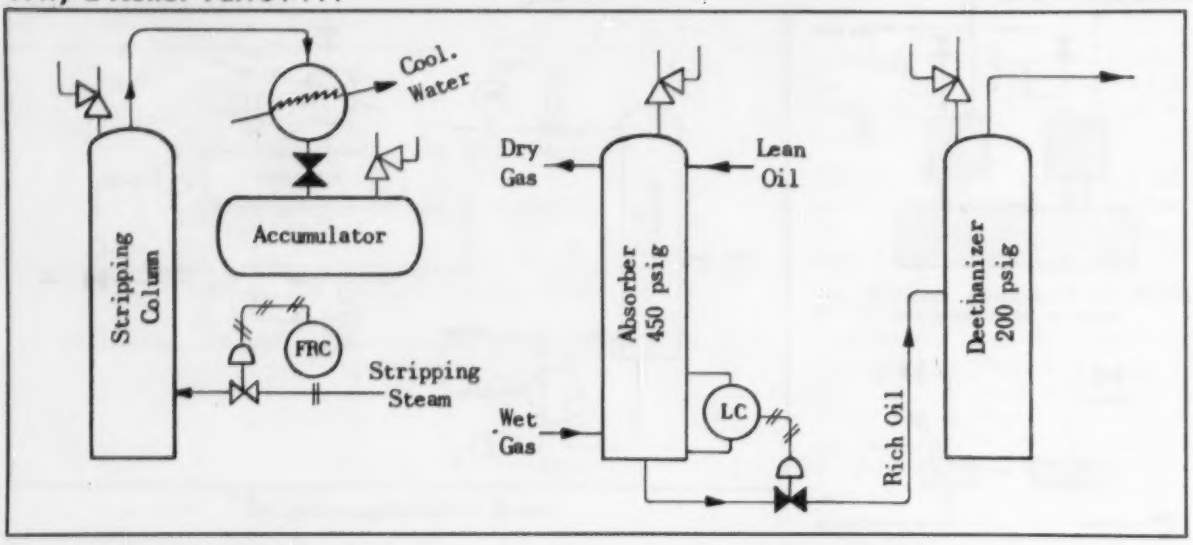

FIGURE 6a—Stripping steam to column.

FIGURE 6b—Absorption unit.

rupture of heat exchangers are the most important of process equipment failures inducing overpressure of allied units.

The pumps may fail due to loss of power or mechanical breakdown. In either case it is a possibility and a likely occurrence.

Exchanger tubes are subject to splitting and consideration should be given to the source of high pressure and its effect on the low pressure side. If, for example, a tube splits and the high pressure is on the tube side, then it is possible to overpressure the shell side, the shell piping, or the associated equipment. The same consideration should be given if the high pressure were on the shell side.

Water Hammer—The rapid shut-off of a valve in a liquid line or the shut-off of a pump may induce water hammer in piping. Water hammer fundamentally is pressure waves transmitting back and forth in a liquid filled pipe.

Sometimes this pressure may reach the point whereby it can very easily rupture piping or equipment. To protect piping and equipment from water hammer, the solution is the use of a relief valve.

Vacuum Relief—Equipment (if not designed for vacuum service) has to be protected against underpressurizing as well as overpressurizing. If the atmospheric pressure on the outside of the vessel is greater than the pressure on the inside, then it is possible to collapse the walls.

Full or partial vacuum in equipment may be caused by any one of the following cases:

(1) Pumping more liquid out of a vessel than is entering.
(2) Draining liquid from a vessel (water, such as after a hydrostatic test, which is most common) without venting.
(3) Injecting cold liquid into a vessel after steaming it out.

The first two cases are quite obvious. Withdrawing liquid without replacing the displaced volume will produce a vacuum. In the third case, if the vessel is full of steam and cold liquid is injected into the unit, then the liquid will condense the steam, reducing considerably the volume occupied by the steam, and thus produce a vacuum.

Conclusion—If one can efficiently diagnose, then the prognosis is easy and the cure practically guaranteed. With safety engineering, such is the case. Namely, diagnosing instances in which equipment may be subjected to overpressurizing or underpressurizing, applying the proper relief or vacuum valves, and thereby insuring safe operation and protection of equipment.

The typical cases cited will take care of approximately 95 percent of all cases in refineries, chemical plants, and power plants.

In the practice of safety engineering, the engineer would do well to consider these generalities: (1) fire, (2) blocked inlets and outlets, or blocked outlets, (3) instrument or equipment failure, (4) water hammer, and (5) vacuum, with respect to operating equipment.

Here is one final thought: The safety features discussed are not mandatory according to law in all cases. However, it is insurance for continuous plant operation and, as mentioned earlier, to protect personnel and equipment. In all probability the safety equipment may never be used —which is good; but, should it be used only once, then it more than pays for itself in rate of return on the investment.

In conclusion, the actual cost of safety equipment is very low in comparison to the over-all cost of most modern plants in operation today; and, cutting corners on safety equipment is equivalent to being penny-wise and dollar foolish.

Exchanger Design

will be spotlighted in the August issue of the *Refiner* when the first of a series on exchangers will appear.

Plan to read these important design features.

ACKNOWLEDGMENT

The writer wishes to thank the management of The Fluor Corporation, Ltd., for the opportunity granted to publish this paper, and also to William H. Williams for his constructive comments and suggestion of title.

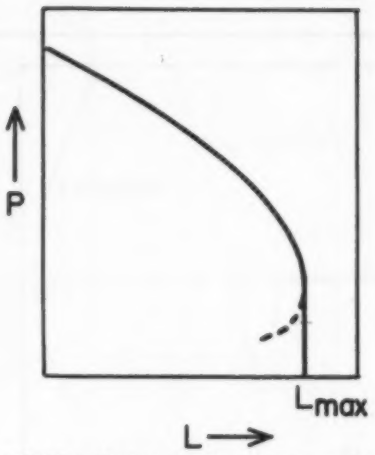

FIGURE 1—Typical variation of pressure with length in a relief pipe.

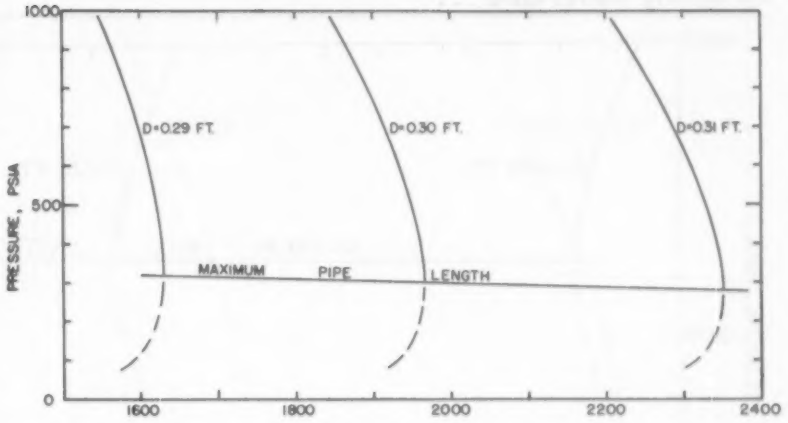

FIGURE 2—Maximum length of relief pipe of various diameter based on Clinedinst integrals.

Designing Relief Lines

It is not necessary to assume that the gases are ideal with this method.

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IN ORDER TO obtain a satisfactory process design, it is necessary to be able to calculate accurately the piping requirements for the system under consideration. It is the object of this paper to present a method for calculating accurately such requirements as may be necessary for the given pipe network for isothermal flow.

For the purpose of this presentation the problem of the design of relief piping for the isothermal flow of a natural gas will be considered. The problem will be solved by the use of the "Clinedinst Integrals."

These integrals are a series of values determined for the $\int_0^{P_r} P_r dP_r/z$ for various reduced temperatures. The integrals were determined by graphical integration for a series of reduced temperatures, and Clinedinst (1) has presented the results obtained for natural gas in the form of a graph of $\int_0^{P_r} P_r dP_r/z$ vs. reduced pressure with reduced temperature as a parameter. Such integrals may be used in solving problems involving the isothermal flow of real gases.

Theory—From the general energy equation for flow through circular pipes, Equation 1, the ideal gas law with the compressibility factor correction, Equation (2), and the equation of continuity, Equation (3) can be derived a method for the design of relief pipes for real gases.

$$\int dp/\rho + \int + {}^{\circ}\overline{a}/_{APA} \int (g/g_c)\, dZ = -W - \int fv^2 dL/2g_c D \quad (1)$$

$$p = Mp/zRT \quad (2)$$

$$w = \rho vA \quad (3)$$

The simplifying assumptions made are as follows:

1. Flow is horizontal.
2. There is no work done in the section of pipe under consideration.
3. Flow is isothermal.

Combining Equations (1), (2), and (3) and rearranging, Equation (4) is obtained. A constant value of the friction factor at the high velocities involved has been assumed.

$$(M/RT) \int PdP/z + (W^2/A^2 g_c) \int dv/v + (fW^2/2g_c DA^2) \int dL = 0 \quad (4)$$

Rearranging and integrating Equation (4) putting $A = \pi D^2/4$, Equation (5) is obtained.

$$\int_{P_1}^{P_2} PdP/z + (16RTW^2/\pi^2 D^4 Mg_c) \ln v_2/v_1 + (8fw^2 RTL/\pi^2 D^5 g_c M) = 0 \quad (5)$$

For simplicity, the quantity C is defined as follows:

$$C = 16RTW^2/\pi^2 D^4 Mg_c \quad (6)$$

Therefore:

$$\int_{P_2}^{P_1} PdP/z + C \ln v_1/v_2 = CfL/2D \quad (7)$$

Combining Equations (3) and (7)

$$\int_{P_2}^{P_1} PdP/z + C \ln \rho_2/\rho_1 = CfL/2D \quad (8)$$

The value of the integral $\int_{P_2}^{P_1} PdP/z$

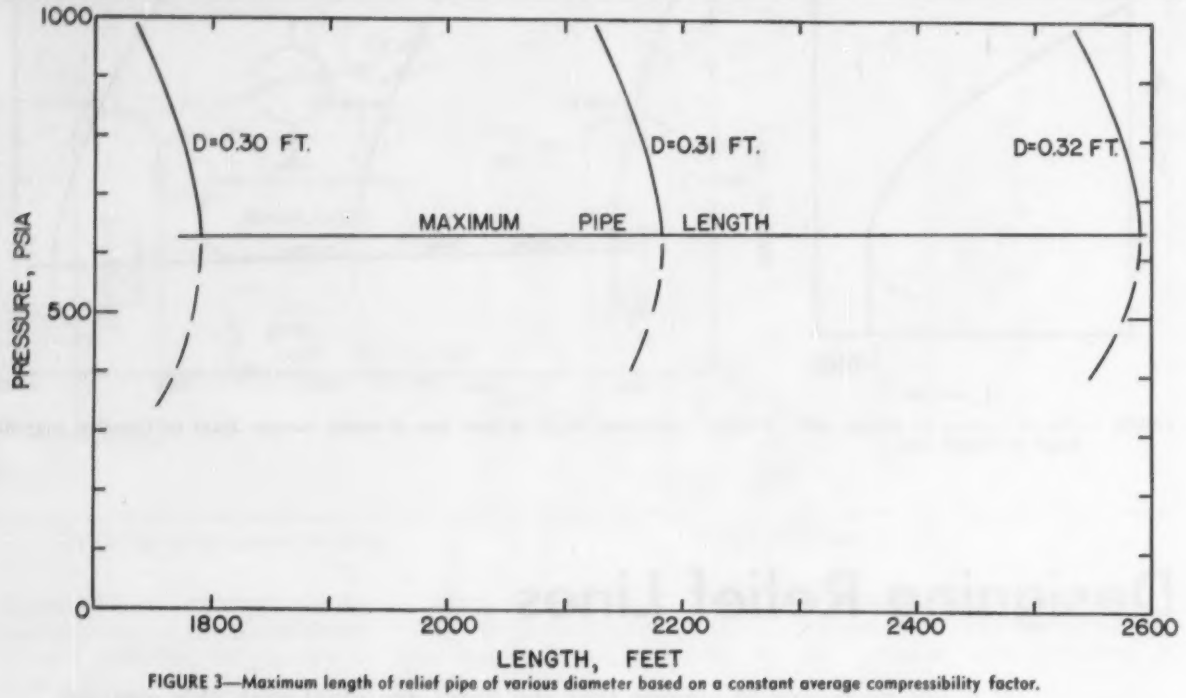

FIGURE 3—Maximum length of relief pipe of various diameter based on a constant average compressibility factor.

was obtained by Clinedinst

(1) for natural gas and may be determined from Equation (9).

$$\int_{P_2}^{P_1} P\,dP/z = P^0_c\left[\int_0^{P_{r_1}} P_r\,dP_r/z - \int_0^{P_{r_2}} P_r\,dP_r/z\right] \quad (9)$$

Applying the Equations—Relief piping can be designed using Equations (7) and (8). Solutions are obtained most readily by assuming a given pipe diameter and flow rate, and then calculating the length of pipe for a given pressure drop. There will be a maximum pipe length at which the gas reaches the velocity of sound. Further decreases in pressure at the outlet of the pipe result only in a sharp pressure drop at the end of the pipe and will not increase either the flow rate or the possible length of pipe. Figure 1 illustrates the general nature of the pressure drop with length. The maximum pipe length is indicated. For assumed pressure drops greater than the maximum the curve has a positive slope. This would mean that there is an increase of pressure with distance, which is impossible and which is shown by a dotted line on Figure 1.

Illustrative Example—A pressure vessel containing natural gas at a

TABLE 1
Pressure Distribution for Three Relief Pipe Diameters Calculated Using the Clinedinst Integrals.

Pipe Diameter, Feet	Exhaust Pressure, Psia	Pipe Length, Feet
0.29	1000	1519
	700	1597
	400	1632
	300	1634
	200	1630
	100	1596
0.30	1000	1822
	800	1890
	600	1936
	400	1961
	300	1965
	200	1961
0.31	700	2287
	600	2311
	400	2343
	300	2349
	200	2347

About the Authors

DAVID CORNELL, formerly an assistant professor of chemical engineering at The University of Texas and now with Monsanto Chemical Company at Dayton, Ohio, is co-author of an article published in the PETROLEUM REFINER earlier this year. The article, "New Design Method of Vent Lines," appeared in the May issue. In addition to his two years' teaching experience, Dr. Cornell's professional background includes two summers with the Texas Petroleum Research Committee at the university and two years with Blaw-Knox Company's Research & Development department. He received all three of his chemical engineering degrees, bachelors, masters and doctors, at the University of Michigan.

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Cornell

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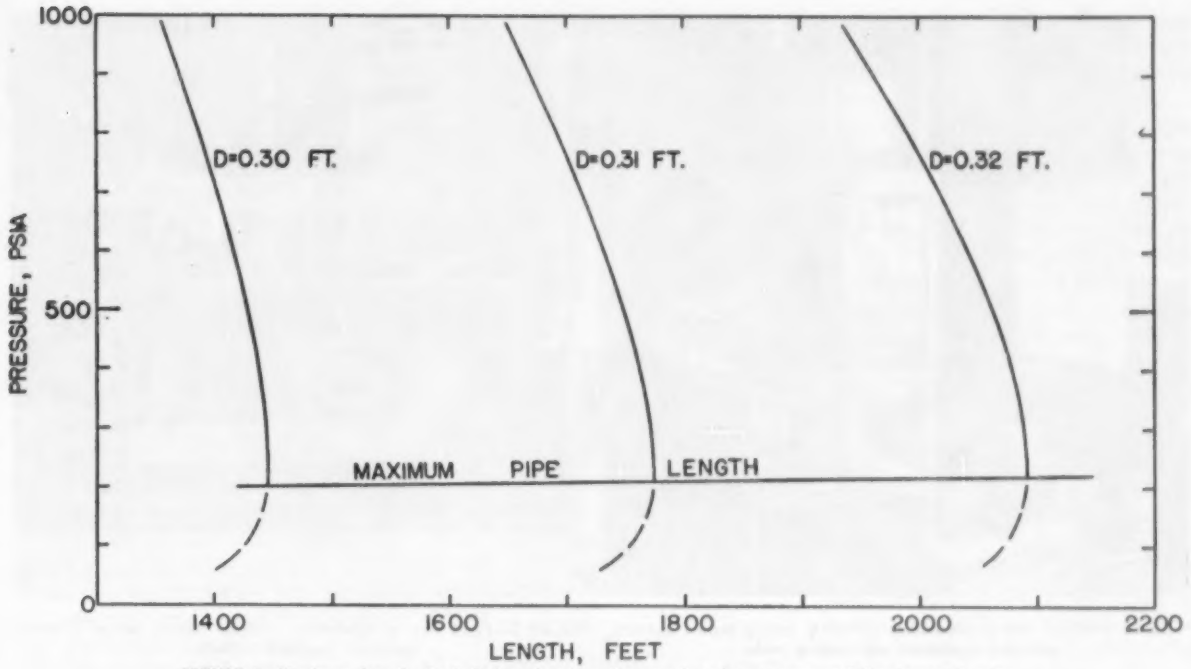

FIGURE 4—Maximum length of relief pipe of various diameter based on a compressibility factor of unity.

temperature of 60 F. and 3000 psia is to be vented to the atmosphere through a pipe having an equivalent length of 2000 feet. The desired discharge rate is 81.7 pounds per second. Assuming horizontal isothermal flow, calculate the pipe diameter required for a pipe with an absolute roughness of 0.0004 feet. The natural gas has the following composition:

Component	Mole Percent
CH_4	88.00
C_2H_6	5.41
C_3H_8	4.70
iC_4H_{10}	0.55
C_4H_{10}	0.60
iC_5H_{12}	0.14
C_5H_{12}	0.14
C_6H_{14}	0.34
C_7H_{16}	0.12
	100.00
	Molecular weight = 19.087

Pseudocritical temperature = 379.23 F
Pseudocritical pressure = 670.24 psia

Solution—The steps involved in the solution of the illustrative example are as follows:

1. Assume a pipe diameter.
2. Assume a downstream pressure.
3. Determine the value of the Clinedinst integral.
4. Calculate the value of the integral $\int_{P_2}^{P_1} PdP/z$
5. Calculate the density ratio logarithm.
6. Calculate the value of the constant, C.
7. Determine the value of the friction factor, f.
8. Using the values obtained, solve for the pipe length.
9. Repeat steps 2 through 8, as necessary, until a critical length is obtained.
10. Prepare a graph of downstream pressure vs. pipe length.
11. Repeat steps 1 through 10.

This procedure is continued until the critical length obtained in step 9 is equal to the desired length of the pipe.

The results of the calculations for the illustrative example are summarized in Table 1 and Figure 2. The calculated pipe diameter using the Clinedinst Integrals is 0.3008 feet.

Calculations were also made both for an average compressibility factor and for an ideal gas. The results of these calculations are shown on Figures 3 and 4. The diameter for an average compressibility factor of 0.72 is 0.3054 feet and for an ideal gas is 0.3178 feet. It can be seen that the diameter calculated for each method is about the same with the ideal gas calculation giving conservative results.

A large difference in the length of the relief piping calculated by the three methods for a given diameter is found. For a 0.3 foot diameter pipe the Clinedinst Integrals give a maximum length of 1965 feet, the maximum length using a constant average compressibility factor is 1790 feet, and the ideal gas solution gives 1440 feet. Again, it can be seen that the ideal gas solution is conservative.

Conclusions—A method for the design of relief piping for the isothermal flow of real gases using the Clinedinst Integrals has been developed and compared with solutions using a constant average compressibility factor and the assumption of ideal gases. The ideal gas solution was found to give a conservative result. Small differences in diameter of the pipe amounting to a maximum of only about 5 percent were obtained by the three methods, but variations in design length of over 25 percent were found for the three methods, the ideal gas solution again giving a conservative result.

NOMENCLATURE

- A — area sq. ft.
- C — constant depending on the gas flowing, flow area, and temperature
- D — diameter of pipe, ft.
- f — friction factor
- g — acceleration due to gravity, ft/sec.
- g_c — gravitational constant, lb. mass (ft.)/lb. force (sq. sec.)
- L — length of pipe, ft.
- M — molecular weight of gas
- P — pressure, psia
- R — universal gas constant, 1544 ft. (lb.)/lb.-mole °R
- T — temperature, °R
- V — specific volume, ft.³/lb.
- v — velocity, ft./sec.
- W — mass rate of flow, lb./sec.
- z — compressibility factor
- ρ — density, lb./cu. ft.

Subscripts

- 1 — initial conditions
- 2 — downstream conditions.

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[1] Clinedinst, W. O., "Flow Equations for Gas Considering Deviations from Ideal Gas Laws," O. & G. Jrl., 43, No. 4, 79 (April 7, 1945).

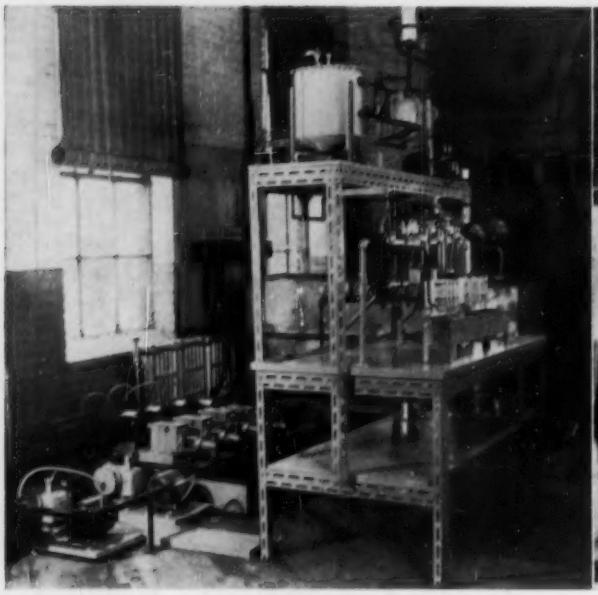

FIGURE 1—Side view of laboratory corrosion testing system showing pumping equipment and feeding tanks.

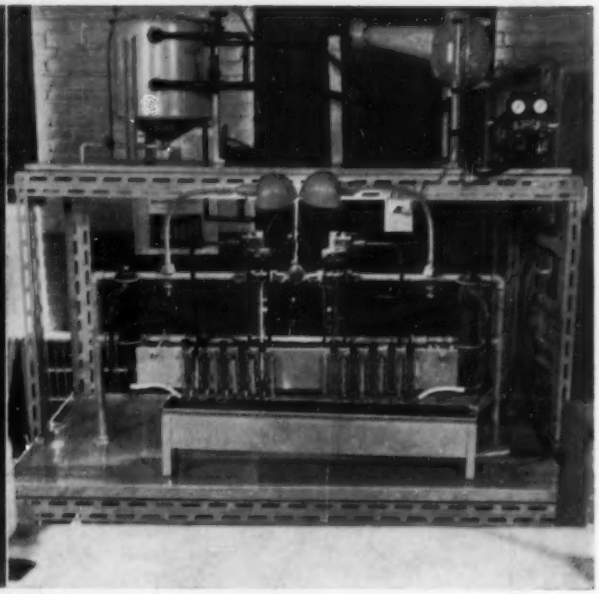

FIGURE 2—Front view of laboratory corrosion testing system showing corrosion specimen holders.

Decreasing Cooling Water Corrosion

A new approach to corrosion prevention in water systems utilizes modifications of the dianodic method of treatment.

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W. H. & L. D. Betz, Philadelphia

CHEMICAL TREATMENT of industrial cooling water systems for control of corrosion is widely practiced, extensive use having been made of corrosion inhibitors such as the chromates, phosphates, silicates and alkalies.

As is well known, anodic inhibitors of the chromate and phosphate type will decrease metal loss, but if used at a concentration insufficient to completely stifle attack, these inhibitors may stimulate pitting and tuberculation. The deficiencies of many corrosion inhibitors in use, particularly from the pitting and tuberculation standpoint were summarized in a paper presented before the 11th Water Conference.[3] Uhlig[1] and Evans[2] also point out many examples of these.

Study of this pitting problem led to the development of the dianodic method, described at the 11th Water Conference. Here is a study of modifications of the dianodic method.

The dianodic method employs two anodic inhibitors—phosphate and chromate—in controlled ratio and under controlled pH conditions to eliminate the pitting tendencies encountered with the separate use of either phosphate or chromate. Laboratory pilot-plant tests have been confirmed in plant operation extending over several years. Data on the highly successful field use of the Dianodic method have been presented by Kahler and Gaughan[4] and Tanzola.[5]

The development of the dianodic method permitted, for the first time the control of pitting and tuberculation at relatively low treatment concentrations, such as 40-60 ppm in the circulating water. The relatively low cost of this method of treatment, together with the effective corrosion control secured, resulted in widespread use of this method in recirculating cooling water systems.

As with any method of corrosion control, the treatment concentration necessary varies in proportion to the corrosion load encountered. While many corrosion problems in the treatment of recirculating cooling water systems can be controlled with a dia-

nodic concentration of 40-60 ppm, unusually severe corrosive conditions may require higher dianodic concentrations. When these higher dianodic treatment concentrations are applied, the corrosion problem can be brought under control.

However, with higher treatment concentration, the orthophosphate concentration of the circulating water will increase. Where the calcium content of the water is high, this higher orthophosphate content can result in exceeding the solubility of calcium phosphate and causing deposit formation. Such precipitation can be prevented either by a decrease in pH maintained in the circulating water or by limiting calcium concentration through increased blowdown.

From an economic standpoint it may be undesirable to increase blowdown. Lower pH values may be undesirable in certain cases from a control standpoint. Consequently, studies were directed toward methods of supplementing the dianodic process which did not involve increase in the orthophosphate content of the circulating water.

Studies were also carried out to see if the power of dianodic could be increased in the lower concentration ranges. Several modifications of the dianotic methods have been developed. The purpose here is to describe these dianodic modifications using zinc as a supplementary treatment. The zinc was used in two distinct applications, one as soluble zinc, and the other as a zinc coating.

Test Apparatus—The laboratory pilot plant system used in these tests is the same as described to the 11th Water Conference.[3] It is a continuous flow system using Philadelphia tap water to which has been added 500 ppm chloride ion to impose an added corrosion load. The test specimens employed were high carbon steel having a composition of 0.9 percent carbon, 1.4 percent manganese, 0.4 percent sulfur, 0.3 percent silicon and no phosphorus. These specimens before exposure were resurfaced using a No. 80 grinding wheel to a machine finish of RMS 20 micro-inches to allow accurate evaluation of pits. At 20 diameters the surface thus prepared was smooth without high polish providing a good surface for counting pits and active areas. Ordinary hot or cold rolled low carbon steel surfaces were found to be too rough to permit even qualitative evaluation of pitting over short testing periods.

Dianodic With Soluble Zinc—The test results shown in Table 1 were secured with the use of one day specimen exposure. As would be expected, the dianodic concentration of 60 ppm phosphate—30 ppm chromate produced excellent results in the control of pitting and tuberculation, as well as in minimizing weight loss. The addition of 10 ppm soluble zinc ion, in addition to this dianodic concentration, produced no perceptible improvement in results.

At a reduced dianodic concentration, however, of 10 ppm phosphate—5 ppm chromate results indicated this treatment concentration to be inadequate for the corrosion load imposed. Numerous pits and tubercles developed. The addition of 10 ppm soluble zinc ion completely eliminated the pitting and tuberculation, as well as decreasing weight loss.

Similarly, a 4 ppm phosphate—2 ppm chromate combination was more inadequate for control of the corrosion load. The addition of 4 ppm soluble zinc ion stifled the pitting and tuberculation.

At the 2 ppm phosphate—1 ppm chromate level, treatment was able to give a 55 percent reduction in steel loss. The addition of 2 ppm soluble zinc ion gave further steel loss reduction of 74 percent and still maintained the general attack pattern.

Soluble zinc ion alone at 10 ppm did not control pitting and tuberculation, although it did give a good reduction in steel loss compared to the experiment without treatment.

A high corrosion load of 0.115 inch per year average penetration was imposed on these tests as shown by the experiment without treatment.

Dianodic With Zinc Coating—While zinc has been shown to be beneficial in the ionic form when superimposed on the dianodic method, the use of zinc under conditions where a coating is formed has also been proved satisfactory. Used in the coating fashion, the benefits of the dianodic method have been extended up to higher pH levels, achieving corrosion inhibition up to pH 8.5. Above pH 8.5 zinc does not form a coating and benefit is not secured. As the pH drops below 7, more zinc or more orthophosphate are required to produce a protective coating.

Figue 2 illustrates the benefits secured against pitting and tuberculation through the use of zinc in the coating range superimposed on a dianodic formulation. The general corrosion rate, as shown by weight loss was also lowered.

The zinc coating was predominately zinc orthophosphate, and possessed excellent adhesive qualities. The coating was deposited uniformly. Since some time is required for such a coating of a metal surface, it is not unreasonable to believe that some of the imperfections exhibited by the results in Table 2 were due to corrosion taking place during the time the coating was being formed. Additional, longer tests, have proved this point.

Further experiments not shown were carried out to measure the effect of pH, polyphosphate, orthophosphate and zinc concentrations. It was found that the thickness of the protective coating could be controlled by increasing the zinc and orthophosphate

Meet the Authors

Kahler

George

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CHARLES GEORGE, as a research engineer under Kahler, is engaged in corrosion studies and research in inhibitory methods. With the Betz company for ten years, he previously was associated with Johns-Manville Corporation, as a member of its Research division. George holds bachelor's degrees in both education and chemical engineering from Pennsylvania State University.

concentrations, and lowering the polyphosphate concentration, as the latter had a solubilizing effect on the coating. The coating also was affected by the pH, i.e., could be made thinner by decreasing pH towards the range where the zinc was completely solubilized. Decreasing the pH and increasing the polyphosphate concentration for a given orthophosphate and zinc level thinned the coating.

Plant Data—Laboratory investigations are always subject to confirmation under field conditions where important variables cannot be controlled as in a laboratory pilot plant system. Case histories will be cited to illustrate the results obtained by supplementing the dianodic method with zinc, both in the soluble and in the coating ranges.

Case History No. 1 — Dianodic With Soluble Zinc Recirculating System

The use of soluble zinc to supplement the dianodic method of corrosion control produced outstanding results at this Western Petrochemical plant. Both natural and induced draft towers are employed in this recirculating cooling water system, with a total circulation rate of 47,000 gpm.

During the first four years of plant operation, little success was secured with several different water conditioning programs. Corrosion and fouling of steel tube bundles was particularly troublesome. During one period of several months operation, bundle failures averaged once weekly even though a semi-yearly cleaning program was in effect.

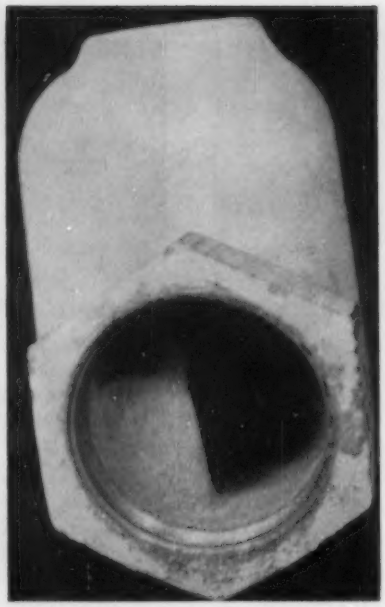

FIGURE 3—Spray nozzle coated inside and out with protective corrosion treatment.

Essentially, the application of dianodic treatment to this system eliminated all but a minor amount of difficulty. However, it was still necessary at plant turn around to clean certain tube bundles operating at high temperature and under critical heat transfer conditions. Scattered pitting and tuberculation were noted in some high temperature sections and some Admiralty exchangers showed slight deposits. Rather than to increase the dianodic treatment concentration, it was decided to supplement the dianodic treatment with soluble zinc.

This revision in treatment accomplished the desired results, practically eliminating the slight difficulties that were still being encountered. The Admiralty bundles which had shown thin deposition had been put back into operation without cleaning, and at the next turn around, these deposits had almost completely disappeared. Constant checks on heat transfer were made by the use of special test heat exchangers, and at the end of the first six months of operation with the dianodic-soluble zinc treatment combination heat transfer had improved to the point that it was almost as good as when the tubes were new.

The use of the soluble zinc ion to supplement the dianodic method of control has been continued with no additional changes, producing excellent results. During the most recent plant turn around only two heat exchangers were acid cleaned. These two exchangers were always cleaned, even before inspection, as an established plant routine since it was desired to obtain the maximum possible cooling from these units.

The characteristics of the makeup water and circulating water are shown in Table 3. Figure 4 covers the plant maintenance record on heat exchangers. Of course, the major improvement was secured with application of the dianodic method which eliminated the failures which had occurred as frequently as every week. The additional improvement in cleaning and replacement by supplementing the dianodic method with soluble zinc was also quite clear cut from this maintenance record.

TABLE 1
Dianodic with Soluble Zinc

$Na_5P_3O_{10}$, ppm	Na_2CrO_4, ppm	Zn^{++} ppm	Weight, Loss, Mg.	Ave. P., "/yr.	Tubercles	Pits
60	30	0	1	0.001	None	None
60	30	10	1	0.001	None	None
10	5	0	4	0.004	Numerous	Numerous
10	5	10	2	0.002	None	None
4	2	0	15	0.015	Present	Numerous
4	2	4	7	0.007	None	General Attack
2	1	0	53	0.053	None	General Attack
2	1	2	30	0.030	None	General Attack
0	0	10	16	0.016	Present	Aggressive
0	0	0	115	0.115	Some	Some, mostly General Attack

Conditions: Philadelphia tap water for feed with 500 ppm Cl, pH 6.0, 120 F, 5-5.5 ppm oxygen, 0.35 f/s water flow, one day exposure.

TABLE 2
Dianodic with Zinc Coating

$Na_5P_3O_{10}$, ppm	Na_2HPO_4, ppm	Na_2CrO_4, ppm	Zn^{++} ppm	Weight, Loss Mg.	Ave. P., "/yr.	Tubercles	Pits
5	1.5	15	0	6	0.006	Numerous	Numerous
5	1.5	15	1.2	2	0.002	Few	Few, shallow
0	0	0	0	145	0.145	Present General Attack mostly	Present

Conditions: Corrosion water contained 120 Ca*, 40 Mg*, 92 alkalinity* 500 Cl, 70 SO_4, 5-5.5 O_2, pH 7.5 120 F, 0.35 f/s water flow, one day exposure.
* As $CaCO_3$.

Case History No. 2—Dianodic With Zinc Coating Recirculating System

An unusually corrosive condition was encountered at a large Eastern linoleum plant. The cooling water system in this plant serves primarily to cool mechanical oxidizers which are jacketed units employed to oxidize linseed oil. Operation is inter-

mittent. Steam is employed through the jackets to raise the temperature to the desired level and then cooling water and steam was introduced in cycling fashion to maintain a fixed temperature until the reaction is completed. Corrosion was so severe that all of the piping had to be replaced every eight months, with attendant costly loss of production.

While a recirculating cooling water system is employed, drains on the system maintain concentration at only 1.2 cycles. Makeup water requirements were 1000 gpm. Analysis of the circulating water is given in Table 5.

The first treatment applied to this problem was a low dianodic concentration of only 20 ppm, in an effort to minimize treatment costs. No pH adjustment was used and the pH of 7.5 was too high for best functioning of dianodic treatment.

Table 6 illustrates test specimen data secured. Even though a rather high initial penetration value of approximately 0.02 inches per year resulted, the differential penetration—that is the loss between the 7th and 21st days—was only 0.002 inches per year. However, tuberculation and pitting were not controlled and this system of treatment was not considered satisfactory.

To increase the dianodic treatment concentration to a more inhibitory level and to adjust pH for best protection was not considered economically feasible. Accordingly, zinc was used at the rate of 4 ppm as Zn to supplement the dianodic treatment and to produce a protective zinc coating.

Table 7 shows test specimen results under these conditions. Average penetration rate was reduced approximately 95 percent. Pitting was completely absent. Test specimens and interior surfaces of piping and equipment available for inspection showed an adherent uniform coating which was gray in color with a slight green shade. Examination of specimens and liners exposed to hot and cold water showed the coating thickness to be practically uniform over the temperature range of 80-180 F.

To prevent the deposition of excessive coating which would interfere with the operation of automatic control valves, concentrations of zinc were successively reduced to a range of 0.8-1.2 ppm as Zn at which level the zinc phosphate coating was barely perceptible on new test specimen surfaces. Once a good protective coating was established, it was possible to maintain this coating at equilibrium conditions with respect to zinc phosphate. Exposure of aluminum, brass and Admiralty specimens in the system showed similar coating indicating that the form of corrosion protection was independent of the metals encountered. Excellent coatings were also produced on couples of dissimilar metals indicating that the treatment responded well against galvanic systems and that the coating was independent of the corrosion process, dependent only on the saturation of zinc phosphate.

While the cooling system in this particular plant serves the mechanical oxidizers primarily, ammonia condensers and air compressors are also cooled with this same treated water. The steel tubes of the ammonia condensers had a previous history of failure due to pitting. Slime formation was also a problem. Following the introduction of the dianodic-zinc coating type of treatment, a coating was deposited within the tubes over all of the existing corrosion deposits and tubercles. This coating so effectively stifled attack that an expected retubing of the ammonia condensers was not necessary. The experience with these units showed that the coating could form over existing corrosion products and reduce attack. Interestingly enough, in these same condenser units, the slime problem improved and gradually disappeared.

Since the use of this combination treatment, repiping of the mechanical oxidizer system has not been required and the maintenance has decreased to practically nothing. Plant records show that the savings thus secured have exceeded the cost of the dianodic-zinc coating type of treatment manyfold. It should be mentioned that while an adequate and protective coating has been deposited and maintained, no loss in heat transfer has been detected. This fact indicates that

TABLE 3
Water Analysis—Case History No. 1

	Makeup Water	Circulating Water (Dianodic)	Circulating Water (Dianodic-Soluble Zinc)
Calcium as $CaCO_3$, ppm	58	250	255
Magnesium as $CaCO_3$, ppm	22	94	95
P Alkalinity as $CaCO_3$, ppm	0	0	0
M Alkalinity as $CaCO_3$, ppm	150	16	12
Sulfate as SO_4, ppm	20	710	714
Chloride as Cl, ppm	29	125	126
Silica as SiO_2, ppm	22	94	95
Total Phosphate as PO_4, ppm	..	20	15
Chromate as CrO_4, ppm	..	12	20
Zinc as Zn, ppm	..	0	2.9
pH	..	6.3	6.0

TABLE 4
Cleaning and Retubing Record—Case History No. 1

Period and Type of Treatment	Admiralty Bundles Cleaned	Admiralty Bundles Replaced	Steel Bundles Cleaned	Steel Bundles Replaced
1st 4 years operation	No exact record—weekly failures at times.			
1st Run—6 months, dianodic	8	1	8	0
2nd Run—6 months, dianodic plus zinc	2	0	4	2
3rd Run—6 months, dianodic plus zinc	0	0	2	0

Total bundles in use:—Admiralty—42, Steel—37.

TABLE 5
Water Analysis—Case History No. 2

	Circulating Water
Total Hardness as $CaCO_3$, ppm	206
Calcium as $CaCO_3$, ppm	147
Magnesium as $CaCO_3$, ppm	59
P Alkalinity as $CaCO_3$, ppm	0
M Alkalinity as $CaCO_3$, ppm	150
Sulfate as SO_4, ppm	104
Chloride as Cl, ppm	18
pH	7.5
Cycles of Concentration	1.2

TABLE 6
Test Specimen Data—Case History No. 2

	Dianodic Treatment—20 ppm (No pH Adjustment)		
Specimen Number*	Weight Loss, mg.	Days Exposed	Ave. P., "/yr.
A-988	397	7	0.054
A-991	389	7	0.053
A-986	400	21	0.018
A-992	454	21	0.021

* Specimens of low carbon steel.

TABLE 7
Test Specimen Data—Case History No. 2

	Dianodic Treatment Plus Zinc Coating		
Specimen Number*	Weight Loss, mg.	Days Exposed	Ave. P., "/yr.
82W	10	8	0.0012
81W	17	15	0.0011
84W	32	22	0.0014
83W	31	28	0.0011

* Specimens of low carbon steel.

this coating type of protection can be practiced without interference with heat transfer by proper control of pH and treatment concentrations.

Case History No. 3—Dianodic With Zinc Coating Once Through System

The prevention of corrosion in once through systems by conventional treatment methods is usually accomplished either by forming a calcium carbonate deposit on the metal surfaces to act as a protective coating, by eliminating dissolved oxygen itself from the water or by the application of small quantities of corrosion inhibitors such as polyphosphate.

Of these methods, the practice of eliminating the dissolved oxygen unquestionably produces the best results. This method however requires the installation of expensive equipment to accomplish mechanical removal of oxygen. Chemical removal of dissolved oxygen by means of catalyzed sodium sulfite in the cold usually is too expensive and therefore the use of this latter method is restricted to very small systems. The polyphosphates are effective in reducing tuberculation but do not substantially reduce corrosion.

The practice of securing corrosion protection from the deposition of calcium carbonate has not been too successful. With different temperatures prevailing throughout a cooling water system, the maintenance of a protective film on the metal surfaces at the lowest temperature requires an oversaturated condition at the point of higher temperature. If the balance is so set that only a small amount of deposit will form at the higher temperature, none will form at the lower temperature and little or no protection against corrosion will be provided at this point. Because of this inherent difficulty, the application of this method to industrial systems is not widely applied.

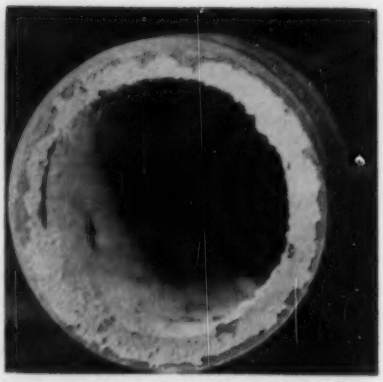

FIGURE 4—Protective coating on spray nozzle from dianodic-zinc treatment.

The application of the dianodic method with zinc coatings at the linoleum plant just described showed such excellent coatings with no measurable difference in thickness between hot and cold temperatures that its application to once through systems appeared to be a definite possibility. Since the existing inexpensive methods of preventing corrosion are relatively ineffective, the need for a more economical and more effective treatment exists.

The application of this dianodic-zinc method of treatment to once through systems at relatively low concentrations has been recently put on test at a steel mill using unfiltered river water for cooling of three ammonia condensers. The condensers are the vertical, open type, and have five water passes. The inlet water temperature is in the range of 80-100 F. and outlet temperature is 165-170 F. For the purpose of this study No. 1 cooler was left untreated, No. 2 cooler was treated by the dianodic-zinc method and No. 3 cooler was only chlorinated for slime control.

Table 8 shows the losses for specimens exposed in each of the five passes. The results for untreated No. 1 cooler show that the corrosion rate of the river water was quite severe, particularly for the last four passes.

The results for the treated No. 2 cooler show that the corrosion was reduced to an acceptable range in each of the five passes. Pitting and tuberculation were also satisfactorily reduced over this short testing period. These results were secured by feeding 26 ppm of inhibitor for 30 days following which the treatment level was decreased to 13 ppm. The double rate of feed was used initially to supply enough inhibitor to reduce the initial attack to a minimum, and to permit the rapid formation of the protective coating. Following the formation of the desired coating, treatment was reduced to a level sufficient to satisfy the solubility product of the protective coating so as to maintain the coating intact.

This initial attempt at treating a once through cooling system has demonstrated that the dianodic method with zinc in the coating range will permit treating these systems economically and reduce corrosion to an acceptable range.

Conclusion—Zinc has been shown by both laboratory and plant performance to be a versatile and effective material for improving an already powerful treatment such as the dianodic method. Whether to use zinc in the soluble or coating range in a matter that must be based on a study of the corrosion problem in individual plant conditions involved. In most instances, either method can be effectively applied. To be useful, zinc must be used with chromate and phosphate since zinc alone possesses little power for corrosion inhibition. Use of phosphate and zinc without chromate has not proven successful enough to be satisfactory. In general, satisfactory results have been obtained with zinc concentrations over the range 0.8-10.0 ppm as Zn. Many factors, of course, affect the zinc concentration required and additional experience will be gained in applying this combination to different types of corrosion problems.

TABLE 8

Test Specimen Data—Case History No. 3
Dianodic Treatment plus Zinc Coating

	Cooler No. 1 Untreated		Cooler No. 2 Dianodic—Zinc*		Cooler No. 3 Chlorinated	
	Loss mgs.	Ave. P., in./yr.	Loss mgs.	Ave. P., in./yr.	Loss mgs.	Ave. P., in./yr.
1st Pass	482	0.008	233	0.004	671	0.012
2nd Pass	857	0.015	201	0.004	1333	0.024
3rd Pass	866	0.016	280	0.005	1088	0.020
4th Pass	1162	0.021	259	0.005	1478	0.027
5th Pass	1431	0.026	350	0.006	1163	0.021

Duration of test 53 days. Cooler No. 1 no treatment. Cooler No. 2 26 ppm dianodic—zinc treatment 30 days and 13 ppm treatment 23 days. Cooler No. 3 chlorination only. Test specimens ½" by 2" low carbon steel.

* The dianodic—zinc treatment consisted of 23 percent disodium phosphate, 35 percent sodium dichromate and 42 percent $ZnSO_4.H_2O$. The cooling water analysis was: 95 Ca as $CaCO_3$, 41 Mg. as $CaCO_3$, 110 alkalinity as $CaCO_3$, 8 Cl, 12 SO_4, 5 SiO_2, and pH 7.5. Inlet T° 80-100, Outlet 167. Calumet River.

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FIGURE 1—Centralized control room: A special data reduction system prepares a typewritten log sheet.

New Refinery Begins with Coker

Built to handle heavy, high-sulfur crude, Union's newest refinery produces only two finished products—coke and sulfur.

Gilbert M. Wilson,
Refiner Staff

SANTA MARIA refinery, a 21,000-barrels-per-day capacity delayed coking plant designed specifically to process heavy, high-sulfur content crudes produced in the Santa Maria, California area, is Union Oil Company's latest addition in a multi-million dollar program of new construction and plant additions.

Officially placed on stream in the latter part of May, the $16.5 million plant processes 15-degree gravity crudes to produce 18,000 barrels per stream day of liquid distillate (gasoline and gas oil), along with 600 tons of coke and 42 long tons of sulfur as by-products. An unusual aspect of the new plant is the fact that its only finished products are coke and sulfur, which, actually, are by-products. The liquid distillates are sent through an 8-inch, 16½-mile products line to the company's marine terminal at Avila, then by tankship to its Oleum refinery in the San Francisco Bay area where they are processed by catalytic cracking and reforming units only recently completed. The Santa Maria plant, located about 12 miles northwest of Santa Maria, has made possible the quadrupling of the gasoline yield of the Santa Maria type crude adding some 7700 barrels per day of high-quality gasoline to the company's former refinery output, and has simultaneously reduced the production of high-sulphur fuel oils formerly produced from that crude.

The site, comprising 110 acres of fenced ground, but with a total of 3256 acres of company-owned area, was selected because of its proximity to crude oil sources, convenience of rail, truck and tankship transportation facilities, availability of coke storage area and possible use of gas oil, produced at the refinery, as a diluent to be injected into the heavy

crude producing wells nearby to facilitate production.

The refinery has two identical but separately operated coking plants, enabling one section to operate while the other is shut down for periodic cleaning and repairs. Because of the dual units, it is not necessary to have large crude oil storage facilities.

Straight-run gasoline and gas oil are taken off in the primary distillation of the crude oil and the remaining material then is sent through a coking furnace and on to one of the two large coke drums, each of them being 18 feet in diameter and 80 feet high. Top of the drums is 105 feet above plant grade and top of the derricks, 214 feet above grade.

Vapors from the top of the coke drums are sent to a fractionating unit to be separated into gas, gasoline and gas oil, the two liquid products being shipped by pipe line and tankship to the company's Oleum refinery.

One of the two coke drums is emptied every 24 hours, coke being cut out by high pressure jets operated through a hollow totating drill stem raised and lowered from the derrick. Coke is dropped into a 35-by-200-foot, by 18 feet deep coke pit adjacent to the drums where water is separated and returned for re-use. The coke is picked up by a three-cubic-yard (five-ton) clam shell bucket, fed into a hopper, then placed on a continuous conveyor belt which takes it to the coke storage area. The conveyor has a capacity of 150 tons per hour.

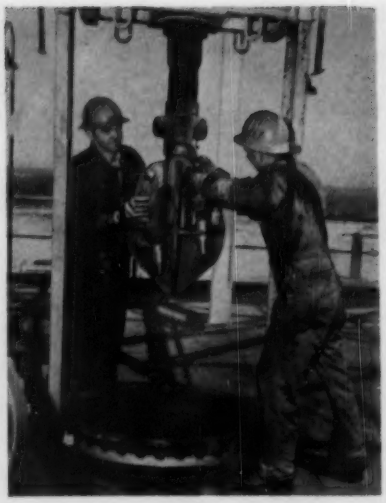


FIGURE 2—High-pressure water jet bit for the initial cut through coke in the drum.

Temperatures, pressures, flows and levels from 600 points in the coking plant, pipe lines and storage tanks, are observed and recorded in the coker control house, main nerve center of the refinery. In addition, a special data reduction system is employed in the refinery. This system, which to date, is being used by only one other refinery in the country, automatically prepares a typewritten log sheet of all significant readings registered by the numerous instruments in the control house. It also averages and records certain data at the end of each day. In addition, the mechanism warns the operator by a buzzer and flashing light, and types a record, when any condition goes beyond a pre-set control range, informing the operator where, and to what extent, the incorrect condition exists.

The sulfur plant, which produces approximately 42 long tons of sulfur per day, was installed principally as an air pollution control measure. Gas, separated from the products coming from the coking plant, contains hydrogen sulfide which is removed from the gas and converted to liquid sulfur. Residual gas from this process is used in the refinery as fuel.

The plant was designed to insure that no annoying or injurius pollutants are released to the air. Smokeless flares are provided for the periodic burning of waste gases; floating roofs are installed on all storage tanks; and pumps are equipped with mechanical seals to eliminate release of hydrocarbon liquids and vapors.

Two wells on the property provide water for processes, boiler feed, decoking, and for domestic purposes. Equipment has been installed to treat water for re-use wherever possible. On the average, water is re-used 15 to 20 times before being discharged to the ocean or lost to atmosphere as vapor. Water which no longer is reusable is thoroughly treated before discharge to the sea to prevent any possible nuisance or injury to marine life.

The refinery was designed and engineered by Union Oil Company's engineering and research process groups in collaboration with Bechtel Corporation, the general contractor. First crude oil was charged to the refinery only 9½ months after actual construction work was started. ##

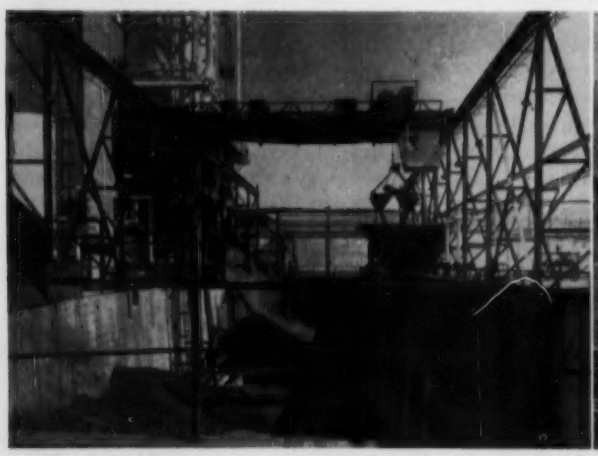


FIGURE 3—Coke cut from drums drops into coke pit, is picked up by clam bucket, fed to hopper and dropped on conveyor belt.

FIGURE 4—Clam bucket (lower left) feeds coke to hopper and conveyor belt. After leaving belt, coke is handled by a coke calcining and marketing firm.

Operations at the Stanlow Refinery

Latest additions to this British plant's refining and petrochemical facilities is a new hydrosulfurization unit.

V. S. Swaminathan
London

BRITAIN HAS NOW become the dominant oil refiner in Europe for three reasons:

- Its great and growing domestic market for petroleum products.
- Its proximity to the Northwestern European markets.
- Its necessity of saving dollars by importing crude mainly from non-dollar sources.

The shutdown of the Persian Abadan refinery in mid-1951 hastened this trend.

The Royal Dutch and Shell organizations have worked together for years, setting up hundreds of companies in virtually every country in the world. Following the last war, this group has come to occupy a front rank among oil refiners in Western Europe, including the United Kingdom. This group and its associates processed a global total of 625 million barrels of crude oil and natural gasoline in 1953, equivalent to a daily average rate of 1,700,000 barrels. The amount processed in the Western European refineries of this company was 159 million barrels during that year.

The Shell Refining and Marketing Company operates four refineries in Britain whose combined crude distilling capacity in mid-1954 was 196,800 barrels per day. These plants are situated in different parts of the country to insure the most efficient distribution of their products.

The Stanlow refinery, located in Cheshire is one of the largest and most complete installations in Europe, producing both petroleum and petrochemical products. Its capacity (barrels daily) breaks down like this:

Crude distillation, 91,000; cracking capacity, 28,000; thermal reforming, 9200; catalytic reforming, 9000; crude oil feed (late in 1954), 78,900; and imported feedstocks (late in 1954), 26,500.

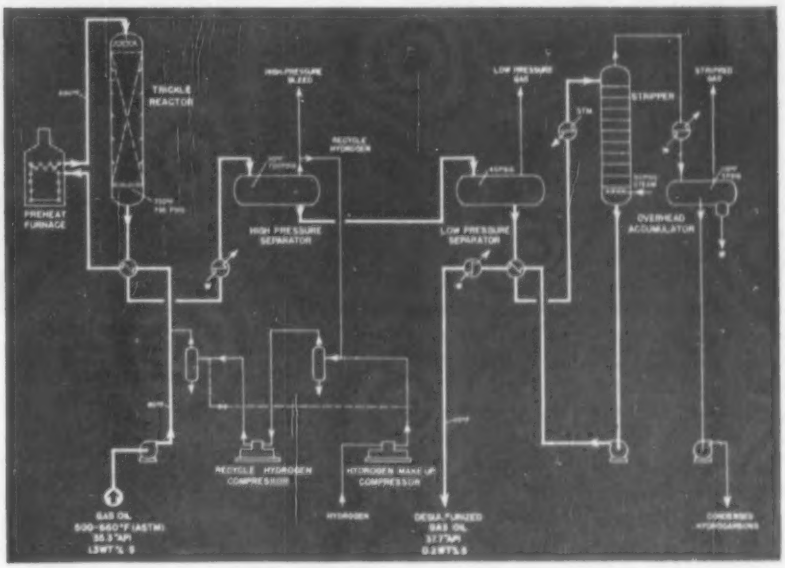


FIGURE 1—Flowsheet of the hydrosulfurization process being installed in this plant.

Starting in 1922 as a tankage installation, from which finished products from foreign processing units were redistributed throughout the country, it has grown, since the second world war, into one of the major integrated European plants, manufacturing from imported crude hundreds of different products including bottled gas, chemical solvents, synthetic detergents, epoxy resins, gasoline, kerosine, diesel oil, lube oil, fuel oil and bitumen.

One of the Leaders—This complex undertaking boasts many "firsts." It is the first in Britain to install a 28,000 barrels daily fluid catalytic cracker; to recover elemental sulfur from refinery gases; to complete a low temperature acid sludge decomposer unit; to erect a Platformer and a complementary isopentane unit; and the first in the world to construct a 5500 barrels per day hydrodesulfurization plant based on the "Trickle process" perfected at the BPM Laboratories in Amsterdam. It also pioneered the quantity production in Britain of a petroleum-based synthetic detergent, petroleum-derived solvents and epoxy resins. The refinery and the petrochemical plant adjoin the Thornton Research Center, focussing the group's research and development activities in U. K. With a salaried staff of 850 the latter establishment is probably the largest in the world, and it prosecutes research on fuel and lubricating oil products, bitumen and petrochemicals —studying, in short, global application problems of petroleum products.

Early Development—To the initial Stanlow storage installation was soon added a bitumen manufacturing plant, which was followed by another

Stanlow Refinery . . .

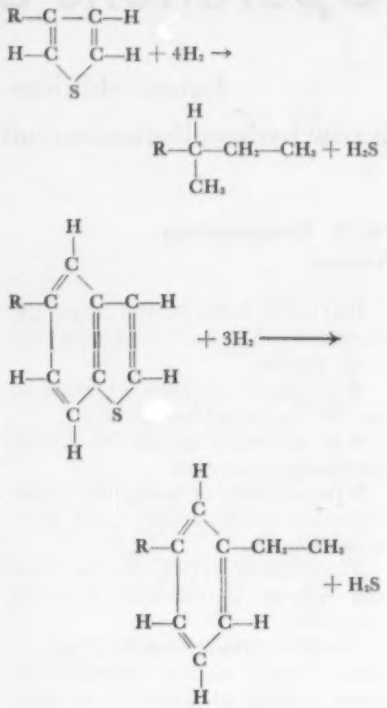
unit for the production of special boiling point (SBP) fractions to meet home demands. In the late 1930's a new continuous blow bitumen plant was constructed. A much larger and more efficient SBP unit was brought on stream in time for its use for the production of nitration-grade benzene and toluene during the early part of the second world war. In that emergency a plant for the manufacture of isooctane from imported raw material was brought into operation. About the same time other specialty items were produced. Thus emerged the Duosol series of installations for turning out high-quality aviation lubricating oils which proved most opportune to Allied air forces. These were accompanied by another series of lubricating oil units designed to produce a wide range of special lubricants for the domestic industry. Also, a process was evolved for the preparation of a wetting and cleansing agent. In 1945 the Stanlow refinery occupied an area of 800 acres and employed 4000 workers. With a crude charging capacity of 17,000 barrels per day it was then the largest specialized installation in the country. This was, and still is, the area now designated Stanlow North.

The New Refinery—The new Stanlow refinery (Stanlow South) was developed as an extension of Stanlow North and integrated with the petrochemicals plant in 1949. Within four years of the start of work, the site was transformed from a bleak marshland into a vast and up-to-date refinery for the complete processing of Middle East crude. The first of the two crude distillation units at Stanlow South was commissioned in 1949, and the major part of the construction job completed by the end of 1952, by which time a thermal reformer and the second crude distillation unit had come on stream. The $20 million Fluid catalytic cracker and its complementary feed-preparation plant also started operation early in that latter year.

Today the refinery site covers an area of 2000 acres, of which nearly two-thirds is occupied by plants, tank farms and distribution facilities. Approximately 16½ miles of road, 14½ miles of rail and more than 700 miles of pipe line provide communication within the refinery area. The plant makes use of 3 million tons of water a year for high-pressure steam, and 90 million kwh. of electricity. The height of the main water cooling tower is 341 feet, the diameter of its pond is 270 feet, and its rating is 5 million imperial gallons per hour. Refinery operations are continuous. Bulk movement of crude oil and products to and from tankers take place at rates of up to 2000 tons an hour.

The Hydrodesulfurization Process—Investigations of the Royal Dutch-Shell group in the BPM laboratories at Amsterdam, directed toward the development of a more economical desulfurization process applicable to a wide range of feedstocks, resulted in the perfection of the "Trickle process." See Figure 1. Here desulfurization is achieved by passing the oil in the liquid phase together with hydrogen downward through a bed of cobalt-molybdenum-bauxite catalyst, or tungsten-nickel sulfide catalyst. The development of the Trickle phase process has not only enlarged the scope of application but also reduced the hydrogen recycle rate to a fraction of that required for vapor phase operation. A 5000 barrel per day hydrodesulfurization unit employing this process is due to start operation at Stanlow early in 1955. It is computed that investment and operating cost for this liquid-phase installation is only 80 percent of that called for by the vapor-phase units that Shell is operating at the present time.

In this Trickle process sulfur occurring in a combined state is removed by substitution with hydrogen. The sulfur compounds in both straight run and cracked gasoline fractions are essentially of the thiophene and benzothiophene structure, with minor quantities of sulfides and mercaptans possibly being present. The main desulfurization reactions are



Under operating conditions normal pressures range from 300 to 750 psia, and average reactor temperature is around 700 F. For deep desulfurization (80-90 percent sulfur removal), pressures of 600 to 750 psi are employed. Under these conditions the carbon-sulfur, carbon-oxygen, and, to a lesser extent, the carbon-nitrogen, bonds are broken, while essentially no carbon-carbon bonds split.

The characteristics for both the

TABLE 1
Feed and Product Specifications—Hydrodesulfurization Unit

	Feed	Product*
Gravity, °API	35.5	37.7
Aniline Point, °F.	162.5	167.5
Bromine No.	1	1
Flash Point, °F.	253	195
Pour Point, °F.	14	.....
Extr. with H_2SO_4, Weight percent	28	25
Conradson carbon on 10 percent residue, weight percent	0.02	.....
ASTM Distillation:		
Initital Boiling Point, °F.	496	455
10 Percent	525	513
30 Percent	538	532
50 Percent	556	550
70 percent	581	577
90 Percent	624	622
Fbp	666	662
Residue, Volume percent	1.0	1.5
Loss	.....	.....
Hydrogen, Weight percent	13.26	.....
Carbon, Weight Percent	85.44	.....
Sulfur, Weight Percent	1.30	0.20
Molecular Weight (Estimated)	243	241
UOP K. Factor	11.9	12.0
Diesel Index	57.7	63.1

* Properties of liquid product obtained experimentally by flashing to atmospheric pressure (i.e., without stripping out light ends).

Meet the Author

V. S. SWAMINATHAN, a native of India and now a consulting engineer in London, is a somewhat regular contributor to the PETROLEUM REFINER—this being his second article to appear this year. His article in the March issue concerned the former Anglo-Irania Oil Company's refinery at Kent. Holder of a M.A. degree from India's Madras University, Swaminathan studied oil technology in London, where he received a M.S. degree from the Royal College of Science.

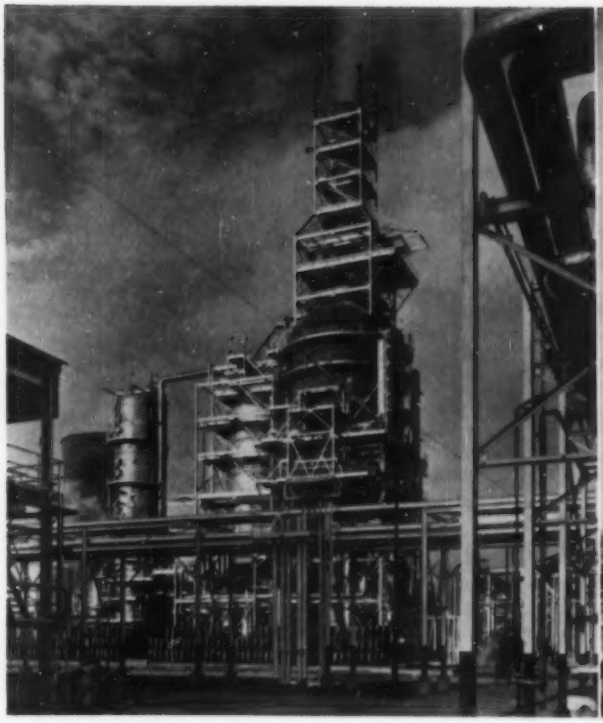


FIGURE 2—The fluid catalytic cracking unit—capacity is 28,000 barrels daily.

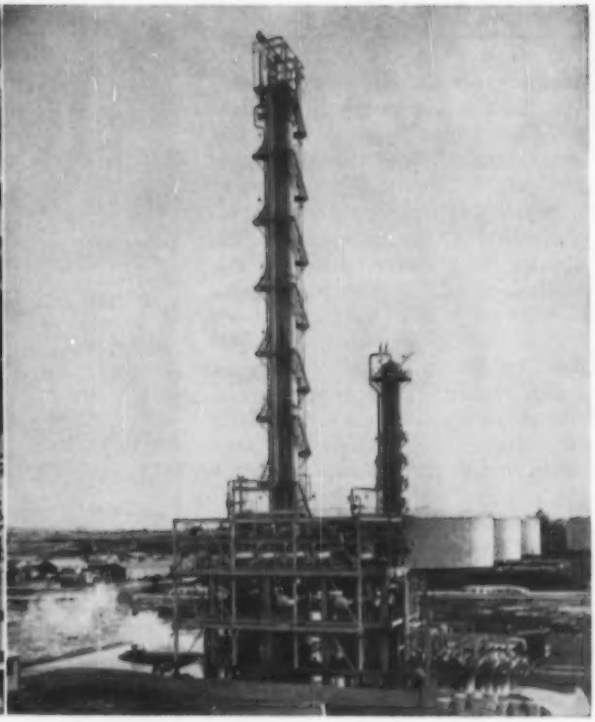


FIGURE 3—This isopentane plant is the first to be constructed in the United Kingdom. The tower is 200 feet high.

feed and product oils when processing Kuwait straight-run gas oil are shown in Table 1.

Catalytic Reforming—Shell's Stanlow Platformer reforms a selected fraction of a straight-run naphtha and operates for the production of high-quality, high-octane blending component used in aviation gasoline manufacture. This unit incorporates several novel features. For instance, reciprocating compressors are driven by condensing steam turbines as opposed to gas or electrically driven compressors normally found in the U. S. Platformers. Heaters are fired with gas, asphalt or fuel oil, and the heater is equipped with an air preheater for recovering waste heat from flue gases. This unit has moreover a waste heat steam generator for additional heat recovery. The flow through the Stanlow Platformer goes through the usual three zones—feed preparation, reactor and stabilization sections. Feed to it first passes through a dry treating process, designed and engineered by Shell, for removing metallic impurities. During production of aviation gasoline the stabilized product, following heat exchange, enters the re-run column. Here it is separated into two fractions to add to the flexibility of aviation gasoline blending operations. The bottoms product can also be used as a feedstock for the recovery of aromatics.

Isopentane Plant—Britain's first isopentane plant at Stanlow, entailing an outlay of $1,400,000, is scheduled for completion in early 1955. This installation should enhance the versatility of the refining system and is complementary to the Platformer which went on stream in late 1953. Here the debutanized light platformate is led through a steam preheater to the depentanizer—an 86-foot column containing conventional bubble-cap trays, where the pentanes are removed as a top product. The de-isopentanizer, a 200-foot column with 140 Turbogrid trays, receives two streams, via steam heaters, i.e., the pentane fraction produced above and debutanized straight-run gasoline. Isopentane is taken as the overhead product. The bottom product consisting of de-isopentanized straight-run gasoline plus the normal pentanes from the platformate are blended into motor spirit. A sphere is available for storing isopentane. Heat for the process is provided by steam at low pressure for preheaters, and high-pressure for reboilers. The de-isopentanizer operates at 25 psig., and the column in question is believed to be the tallest in the world.

Petrochemical Operations—Both the reforming and catalytic cracking processes yield light hydrocarbons, normally as gases. At this stage oil refining merges into the manufacture of petrochemicals. The leading chapter in this development in Britain was opened in 1949 when the Stanlow chemical solvents plant went on stream. This group of integrated installations brought an entirely new enterprise to Britain and in so doing aided easing the nation's post-war economic problems. Hydrogen sulfide is one of the products of the catalytic cracker, an impurity which must be removed from the fractions of the gas-separation unit before they can be used in the chemical plant. It is converted into elemental sulfur.

The Stanlow petrochemicals plant uses gas oil as feed stocks. This is fed into the thermal cracking unit where it is cracked at elevated temperatures and low pressures to obtain the maximum formation of gaseous products. The cracked items are roughly separated into heavy fuel oil which is burned and a mixture of light components. The latter mixture is fed

into a gas-separation unit and split into five fractions: a mixture of light gases containing hydrogen, methane, ethane, and ethylene which is burned; three others containing hydrocarbons with 3, 4 and 5 carbon atoms respectively; and a volatile liquid which is blended into motor gasoline. The fraction containing five carbon atoms is returned to the cracking furnace and is further pyrolized. The two fractions with three and four carbon atoms contain a high proportion of reactive olefins, and it is these C_3 and C_4 fractions which form the feed stocks for the manufacture of chemical solvents. Under suitable conditions acetone, derived from isopropyl alcohol is converted to diacetone alcohol which, in its turn, is transformed to methyl isobutyl ketone via mesityl oxide.

Like several other oil processers, Shell at Stanlow has lately landed in the sulfur production business as an adjunct to its routine hydrocarbon operations for several reasons—the high sulfur content of the Middle East crudes it employs; acute supply shortages of this key commodity following the second world war; and the effluent disposal problems closely linked with sulfur removal and sulfuric acid treatment of petroleum and petrochemical products. Extraction of this element from refinery gases has assumed great importance in Britain on two additional grounds—lack of domestic supplies and the need to import the bulk of this commodity from the United States, entailing substantial dollar outlay. The Girbotol process is in use at Stanlow for the removal of H_2S from refinery gases employing diethanolamine as reagent. An H_2S gas holder has been installed since it confers a larger measure of operational flexibility by tending to dampen out variations in feed rate and composition, and permits more time for emergency action than is possible with a direct feed line between the Girbotol plant and the Claus unit. This plant accounts for around 45 long tons of sulfur of higher than 99.9 percent purity a day. Mild steel equipment has been found satisfactory, and little danger of corrosion exists provided temperatures are controlled within certain limits—high enough to avoid water vapor condensation, and low enough to circumvent sulfide formation and SO_2 production which can occur in the presence of excess air. Explosion discs are provided to safeguard equipment, and because of the toxic nature of H_2S provision has been made to enable the unit to be shut down by remote control from a safe location.

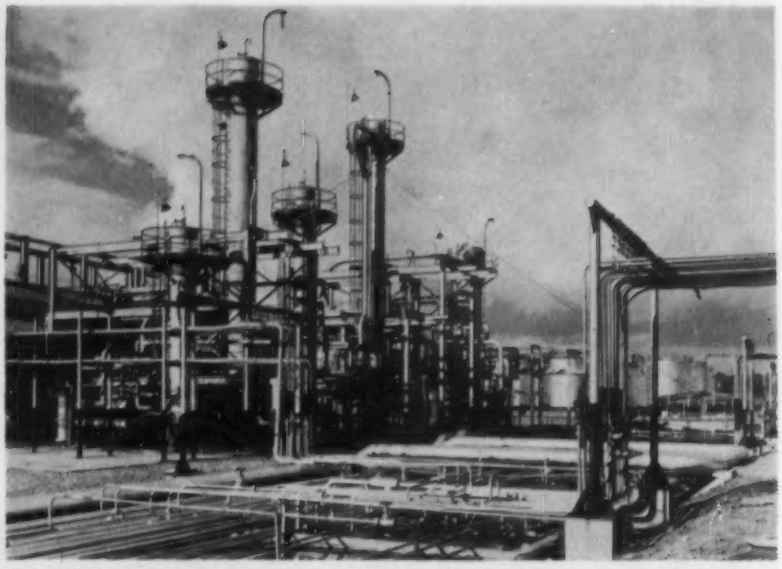


FIGURE 4—This unit produces diacetone alcohol, mesityl oxide and methyl isobutyl ketone.

The oil refining as well as the petrochemical operations use large quantities of sulfuric acid, resulting in the production of spent acid, acid sludge or acid tar. The disposal of such sludges has posed a problem especially in areas where regulations preclude the discharge of acid to sewers and of acid fumes to the atmosphere. A low temperature sludge decomposer plant is slated to start functioning at Stanlow in early 1955. Sludges from the refinery are stored in the plant feed tanks maintained at around 40 C., and with certain sludges of high inorganic matter content provision has been made for their immediate usage since long-term storage renders them unpumpable. Sludge circulation and feeding to the kiln is carried out by steam reciprocating pumps, and transfer lines are steam traced. The sludge decomposition facet of the process entails operation of the coke feed bin, coke feeder, coke heating kiln, sludge decomposing kiln and coke handling equipment. Exit gases from the decomposer are mainly a mixture of SO_2, CO_2, steam, hydrocarbon vapors and dust. Purification is essential before this stream is fed into the Contact plant. This is effected by a gas scrubber, cyclone separator and oil and dust separating vessels, an SO_2 furnace, cooling towers, stripping tower and an electrostatic mist precipitator. Finally, uncondensible hydrocarbons, detrimental to the Contact unit, are removed by combustion with excess air in the SO_2 furnace in which liquid sulfur and H_2S can also be burnt to furnish additional SO_2. The transfer of gases throughout the unit is effected by the main blower situated downstream of the drying column on the Contact plant.

Dock Facilities—The Queen Elizabeth II oil dock and lock at Eastham was commissioned by the Manchester Ship Canal Company in 1954 to provide discharging facilities to several oil industry undertakings including Shell Petroleum Company. A unique feature of this dock is the provision of oil weirs, consisting of a set of grills at each of the four corners of the dock, and if oil should spill from a tanker a reverse penstock goes into operation sucking the surface mixture of oil and water into a system of chambers situated deep in the concrete dock walls. Here the oil is skimmed and collected, it being thus feasible to recover up to 400 imperial gallons which can be pumped back into the pipe lines. These oil weirs also lessen fire hazard risks. Shell's new Eastham installation, built on an 18 acre site at the entrance to this ship canal, is capable of accommodating simultaneously four tankers of up to 32,000 deadweight tons each.

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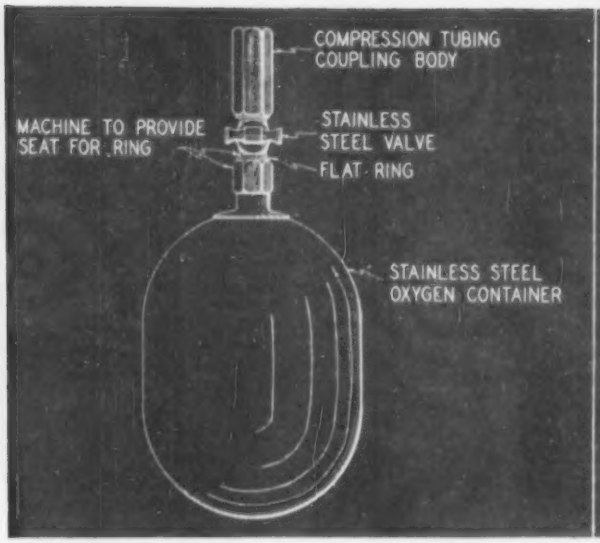

FIGURE 1—Pressure vessel used in this determination.

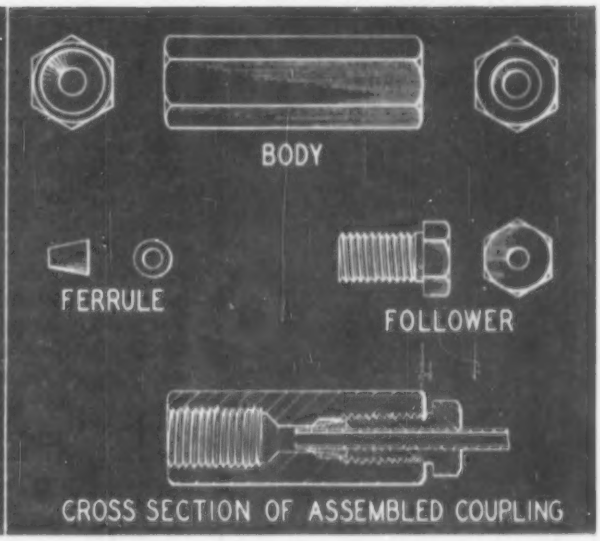

FIGURE 2—Various parts of the compression tubing coupling and its assembly.

Is Carbonyl Sulfide in LPG Corrosive?

Test results indicate that carbonyl sulfide does not cause the corrosion of handling or storage equipment for LPG.

Kurt H. Nelson, Dean Veal and B. J. Heinrich,
Phillips Petroleum Company,
Bartlesville, Okla.

CARBONYL SULFIDE is one of the impurities found in varying concentration in liquefied petroleum gas produced in present refinery operations. The souring of sweetened liquefied petroleum gas has been attributed to the decomposition of residual carbonyl sulfide not removed in the customary caustic scrubbing. It has been suggested that the presence of carbonyl sulfide is partly responsible for the corrosion of refinery equipment.

Information on the behavior of carbonyl sulfide in liquefied petroleum gases appears to be lacking in the literature. Therefore, the following exploratory experiments were conducted.

These experiments showed that (1) carbonyl sulfide does not produce a tarnished strip in the copper strip corrosion test, (2) carbonyl sulfide in LPG does not decompose to elemental sulfur or other corrosive sulfur compounds to any degree during storage up to eleven months under various conditions and temperatures, and (3) metallic copper does not promote the decomposition of carbonyl sulfide in LPG to any extent during storage.

Apparatus and Methods—The pressure vessels used for the preparation and storage of the various blends of carbonyl sulfide, propane and water were 1.7-liter stainless steel oxygen containers fitted with stainless steel valves and compression tubing coupling bodies as shown in Figure 1. The details of the compression tubing coupling are given in Figure 2.

TABLE 1
Properties of Carbonyl Sulfide

PROPERTY	Value	Reference
Molecular Weight	60.07	(2)
Color	Colorless	(5)
Odor	Odorless	(5)
Freezing Point, °C.	−138.8	(1)
Boiling Point, °C. 760 mm.	− 50.2	(1)
Density:		
Gas (25 C., 760 mm)	2.485	(1)
Liquid (−87 C.)	1.24	(2)
Solubility:		
Alcohol	Very soluble	(2)
Alkali	Very soluble	(2)
Water (per 100 gm H_2O)	0.356 gm (0 C.)	(3)
	0.147 gm (20 C.)	(3)
	0.104 gm (30 C.)	(3)

The filling adapter and pipet used to introduce water into the pressure vessels are illustrated in Figures 3 and 4.

A mercury manometer was used to measure small amounts of carbonyl sulfide into the pressure vessels. The manometer was calibrated by determining the volume of gas contained in the manometer at various pressures. Using these volumes and the density of carbonyl sulfide, a graph of milligrams of carbonyl sulfide versus pressure in millimeters of mercury was plotted.

The samples containing carbonyl sulfide, propane, and water were prepared in the following manner. After the pressure vessel was evacuated, it was connected to the calibrated manometer using the compression tubing couplings. A known volume of carbonyl sulfide was measured into the evacuated vessel by means of the manometer. The vessel was then disconnected from the manometer, and the filling adapter was inserted in the coupling body on the vessel. Water was then added through the adapter with the pipet. After the adapter was removed, the vessel was weighed. It

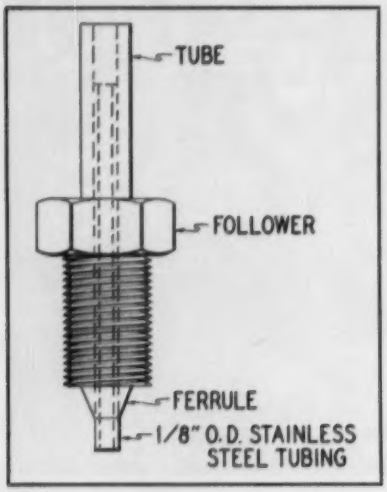

FIGURE 3—Construction and assembly of the filling adapter used.

was then filled with the desired quantity of liquid propane and reweighed. Finally, the concentration of carbonyl sulfide in parts per million was calculated. The dry samples were prepared in a similar manner except the addition of water to the vessels was omitted.

The copper strip corrosion tests were conducted according to the procedure given in NGAA Publication 2140 (1951).

Experimental—The literature does not mention the effect of carbonyl sulfide on copper strip corrosion tests. To determine if carbonyl sulfide would give positive results, a sample of liquid propane containing 10.6 ppm carbonyl sulfide was prepared. A number of copper strip corrosion tests were made immediately on the liquid phase of the sample. No corrosion was found on the copper strip at the conclusion of each test.

Carbonyl sulfide will undergo hydrolysis to form carbon dioxide and hydrogen sulfide. However, kinetic studies[4] of this reaction in aqueous and alcoholic solutions, and in the gas phase show the hydrolysis to be very slow. To investigate the extent of carbonyl sulfide decomposition during storage of liquefied petroleum gases, samples of the compositions shown in Table 2 were prepared:

TABLE 2

SAMPLE No.	Carbonyl Sulfide, ppm.	Propane, gm.	Water, gm.
I	9.0	683	0
II	8.0	656	5
III	58.3	346	5

These samples were stored where the daily temperature varied from 50 to 100 F. At one month intervals during the first three months of storage, portions of the liquid phase of each sample were withdrawn for copper strip corrosion tests. Number 0 strips on the copper strip corrosion scale given in ASTM D130-50T were still obtained in these corrosion tests at the end of the third month. The samples were then stored for an additional eight months before copper strip corrosion tests were again conducted on the samples. No corrosion was found on the copper strips in the tests made on Samples I and II. A few scattered spots were found on the copper strip in the test performed on Sample III.

The copper strip corrosion tests showed that metallic copper does not cause decomposition of carbonyl sulfide during short periods of contact. To determine the effect of metallic copper on the stability of carbonyl sulfide during storage, a sample of 325 gm propane containing 58.3 ppm carbonyl sulfide, 5 gm water and two polished copper strips was prepared in a pressure vessel. The sample was stored for one month under the same conditions as the above samples. After storage, a copper strip corrosion test conducted on a portion of the liquid phase of the sample gave negative results. Examination of the strips stored in the vessel showed that each had a very faint tarnish which was only slightly more than that of Number 0 on the ASTM copper strip corrosion scale. It has been reported that the presence of 0.014 ppm elemental sulfur will give a strip between Number 0 and 1.

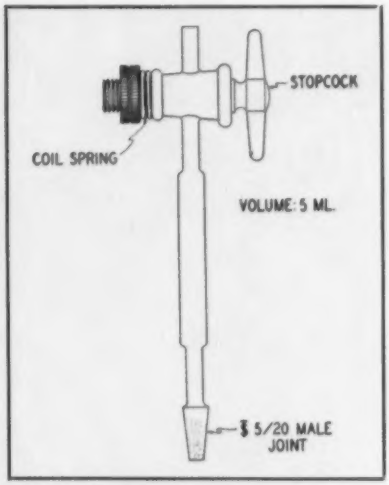

FIGURE 4—Pipette and stopcock used.

Conclusions—On the basis of these experiments, it may be concluded that carbonyl sulfide in LPG does not affect the results of the copper strip corrosion test, does not decompose to elemental sulfur or other corrosive sulfur compounds to any degree during storage up to 11 months under various conditions and temperatures, and that metallic copper does not react with carbonyl sulfide in LPG to any extent during storage.

Heinrick Veal Nelson

Meet the Authors

B. J. HEINRICK has been manager of Phillips Petroleum Company's analytical laboratory at Bartlesville, Okla. for the past 10 years. He joined Phillips in 1943, after five years at the University of Oklahoma where he was a member of the chemistry faculty. He has completed all the course work for a Ph.D.

D. J. VEAL, a research chemist under Heinrick, is responsible for developing new analytical techniques for Phillips. Associated with the company four years, he previously held a research position with Ansul Chemical Company and had worked for Arizona Chemical Company and U. S. Gypsum Company. He holds a bachelor's degree from Texas Technological College and a master's from Ohio State University.

KURT H. NELSON, also engaged in analytical research at Bartlesville, was born in Sweden. He was graduated from Reed College and received a doctor's degree at the University of Washington. He, like his co-authors, is a member of ACS.

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[1] Kemp, J. D., and Giauque, W. F., J. Am. Chem. Soc., 59, 79-84 (1937).
[2] Lange, N. A., "Handbook of Chemistry," 8th Ed., Handbook Publishers, Sandusky, Ohio, p. 218-9.
[3] Seidell, A., "Solubilities of Inorganic and Metal Organic Compounds," 3rd Ed., Van Nostrand, New York, Vol. 1, p. 238.
[4] Thompson, H. W., Kearton, C. F., and Lamb, S. A., J. Chem. Soc. (London), 1935, 1033-7.
[5] Thorne, P. C. L., and Roberts, E. R., "Inorganic Chemistry," 4th Ed., Interscience, New York, p. 846-7.

Determine Vessel Weights Graphically

A new chart solution for the weight of vessels and accessories is presented.

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Singmaster & Breyer, Inc.
New York

THE CALCULATION of vessel weights involves compiling figures for the shell or cylinder, the heads, the skirt, the base ring and lugs and the manways and nozzles. If the vessel under consideration is a tower, then one must gather additional data—namely tray support and downflow plate weights. Several slide rule calculations are involved and a figure is finally arrived at by adding all the collected items together. The result may end up as 57,376 pounds which could be rounded off to 57,400, or 57,500, depending upon the estimator's consideration of the problem. Other refinements in weight calculations may be resorted to so that the final result is an accurate forecast of the finished vessel weight.

Much of the time consumed in these calculations is eliminated by the use of the accompanying graph, Figure 1. In addition to saving calculating time, the graph makes it extremely simple to determine the effect on vessel weight by changing the diameter and/or length of a vessel.

The graph is based on the following formula:

$$W = 40.8\,\pi\,D\,t\,(L + Ll)$$

wherein

W = Weight of Shell and 2-Ellipsoidal Heads.
D = Diameter of Vessel in feet.
t = Thickness of Vessel in inches.
L = Tangent to tangent length of shell.
Ll = Lineal feet of shell equivalent to weight of two ellipsoidal heads.

The graph is divided into three parts: (1) a group of lines representing the weight of one lineal foot of cylinder of a given diameter and shell thickness; (For reasons of clarity and to simplify reading of the graph, shell thicknesses in 1/16-inch divisions have been omitted but may easily be interpolated. Lines representing ODD ⅛-inch thicknesses are not labeled in the graphs.) (2) a group of lines representing multiples of these cylinder weights in five (5) foot increments;

Text concluded on Page 160. Note charts on two intervening pages.

* Formerly with The Lummus Company, New York.

TABLE 1

FOR WEIGHT OF 2-ELLIPSOIDAL HEADS ADD THE FOLLOWING EQUIVALENT CYLINDER LENGTHS

DIAMETER	Equivalent Length
2′—0″	2′—0″
2′—6″	2′—5″
3′—0″	2′—9″
3′—6″	3′—5″
4′—0″	3′—5″
4′—6″	4′—4″
5′—0″	4′—9″
5′—6″	5′—3″
6′—0″	5′—8″
6′—6″	6′—1″
7′—0″	6′—6″
7′—6″	7′—0″
8′—0″	7′—5″
8′—6″	7′—10″
9′—0″	8′—2″
9′—6″	8′—8″
10′—0″	9′—0″
10′—6″	9′—6″
11′—0″	10′—0″
11′—6″	10′—4″
12′—0″	10′—9″
12′—6″	11′—2″
13′—0″	11′—8″
13′—6″	12′—0″
14′—0″	12′—6″
14′—6″	12′—11″
15′—0″	13′—4″
15′—6″	14′—0″
16′—0″	14′—6″

Meet the Author

H. J. DeLAMATER first because interested in determining the weight of pressure vessels graphically while with The Lummus Company. It was necessary to weigh as many as 20 or 30 vessels a day, and DeLamater had to find a way to save time. With the help of Reynold Grasso, of Lummus, he started drawing the charts which were used to step up the operation. Now chief estimator for Singmaster & Breyer, Inc., he is responsible for preparing cost estimates for chemical and metallurgical plants. A 1933 University of New York graduate, DeLamater's background in the industrial-construction business includes 27 years with such companies as Lummus, The W. M. Kellogg Company and Foster Wheeler Corporation.

TABLE 2

WEIGHTS OF SADDLES

DRUM DIA.	Approx. Wt. 2 Saddles (Pounds)
2′—0″	120
2′—6″	150
3′—0″	180
3′—6″	210
4′—0″	250
4′—6″	500
5′—0″	550
5′—6″	600
6′—0″	650
6′—6″	950
7′—0″	1050
7′—6″	1150
8′—0″	1550
8′—6″	1700
9′—0″	1850
9′—6″	1950
10′—0″	2050
10′—6″	2150
11′—0″	2300
11′—6″	2400
12′—0″	2550

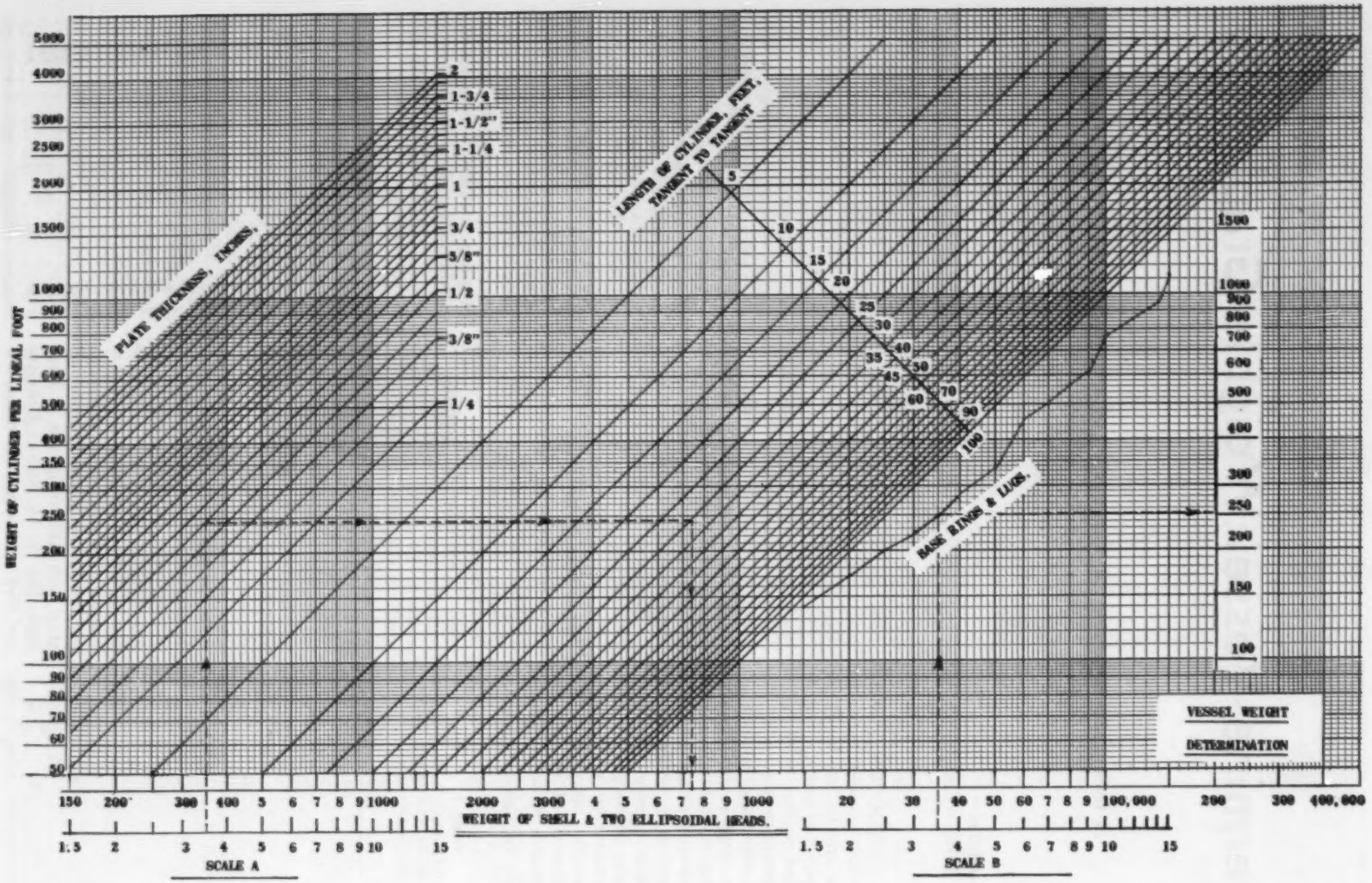


FIGURE 1—Chart for determining weight of cylinder.

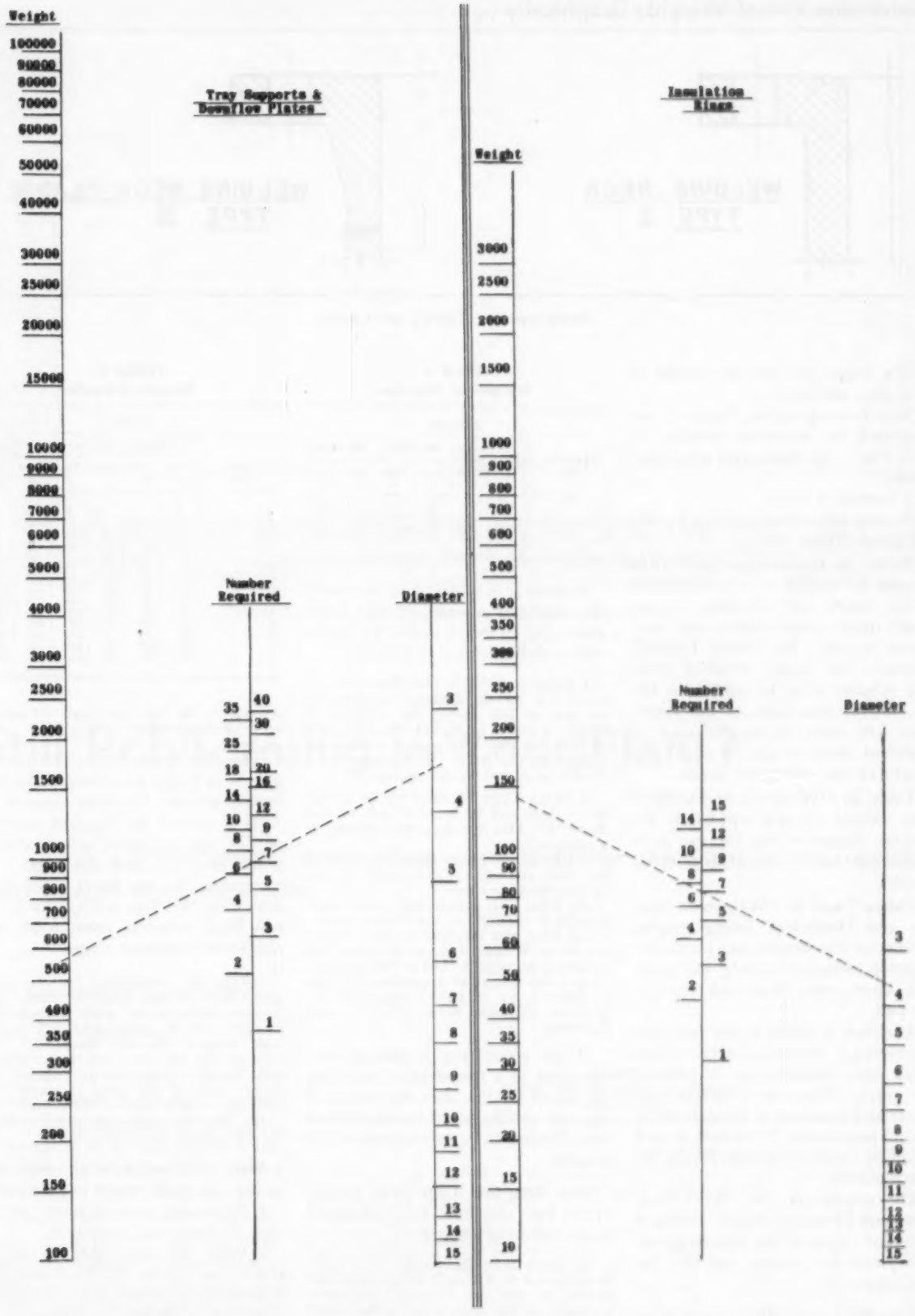
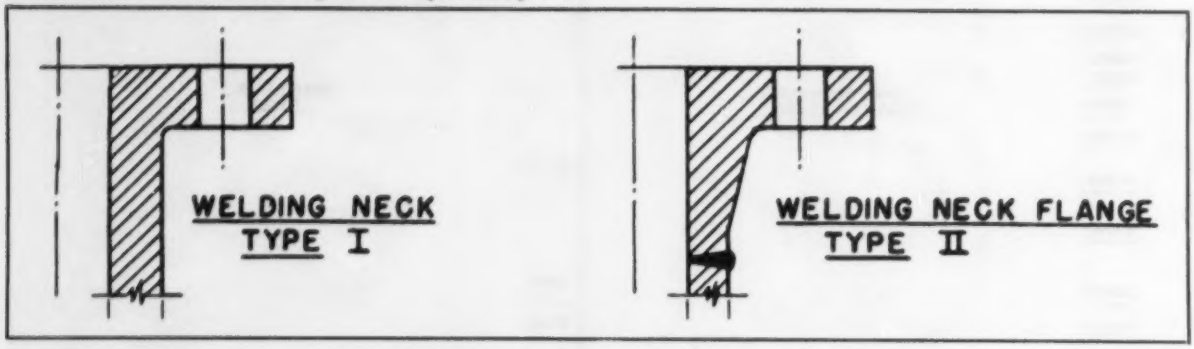


FIGURE 2—Nomogram for determining weights of tray supports and downflow plates, and insulation rings.

Determine Vessel Weights Graphically . . .



Nozzle types. See Tables 3 and 4 below.

(3) a single line for the weight of base rings and lugs.

Two nomagraphs, Figure 2, are presented for obtaining weights of:

1. Tray supports and downflow plates.

2. Insulation rings.

Several tables are furnished with the graph. These are:

Table 1—Equivalent cylinder lengths for weight of two ellipsoidal heads. Select the diameter of the vessel under consideration and read across to the "Equivalent Length" column. The figure obtained from this column is to be added to the TL to TL dimension of the vessel. This will result in the inclusion of sufficient shell weight to equal the weight of two ellipsoidal heads.

Table 2—"Weights of Saddles." The weights shown opposite the various diameters are for use with horizontal tanks requiring steel saddles.

Tables 3 and 4—"Weights of Nozzles and Manholes," listing weights of various size nozzles and manholes. Manhole weights include the manhole, cover, bolts, davit and reinforcing pad.

Attention is called to the fact that overweight tolerances have been taken into consideration in plotting the graph. These are 7 percent for plates and heads up to ¾-inch thickness; 5 percent for 13/16-inch to and including 1-inch; 4 percent for 1-1/6-inch and over.

The nomagraph for "Tray Supports and Downflow Plates" is based on 2-foot tray spacings, ⅜-inch downflow plates and various size bars for tray supports.

Example Cited—Following is an example to show the use of the graph:

TABLE 3
Weights of Manholes

Manhole Size	RATINGS 150 Pounds Type I	150 Pounds Type II	300 Pounds Type I	300 Pounds Type II	600 Pounds Type I	600 Pounds Type II
16	580	490	920	815	1360	1365
18	665	585	1105	1010	1660	1655
20	820	720	1335	1260	2105	2060
24	1165	1050	1995	1875	2880	2890

Assume it is required to determine the weight of a vessel 3½ feet in diameter by 26 feet, 7 inches TL to TL with a shell thickness of ½ inch.

1. Refer to Table 1 (see Page 157.) A vessel 3½ feet in diameter requires, for the use of this graph, the addition of 3 feet, 5 inches to the TL-TL dimension so that the final reading will include the weight of the heads. This results in a TL-TL of 30 feet for the example.

2. In the lower left-hand border of Figure 1 there will be found a scale labeled Scale "A". This represents the diameter of a cylinder in feet.

(a) Enter the graph from this scale at 3½ feet and move vertically to the ½ inch thickness curve.

(b) From this intersection move horizontally to the right to the 30-foot curve.

(c) From this intersection move vertically to the bottom of the graph where the weight of the vessel is read as 7400 pounds. This is the weight of a cylinder 3½ feet in diameter by 26 feet, 7 inches TL-TL plus two ellipsoidal heads, all of ½ inch thickness.

If the vessel is a horizontal one, operating at a temperature requiring the use of saddles, then the weight of the two saddles could be determined from Table 2 to be approximately 210 pounds.

Base Ring and Lugs—The weight of the base ring and lugs is obtained in the following manner:

(a) Enter Scale "B" in the lower right-hand border of Figure 2 at the vessel diameter, in this case 3½ feet, and move vertically to the intersection of the curve marked "Base Ring & Lugs."

(b) From this intersection move horizontally to the right and read the weight on the scale provided.

TABLE 4
Weight of Nozzles

Nozzle Size	RATINGS 150 Pounds Type I	150 Pounds Type II	300 Pounds Type I	300 Pounds Type II	600 Pounds Type I	600 Pounds Type II
1	6	3	8	5	9	7
1½	9	5	14	10	14	12
2	12	9	15	12	17	14
2½	16	12	20	16	25	20
3	20	15	30	20	30	25
4	30	20	30	30	55	45
6	65	40	95	55	140	105
8	90	55	130	80	190	145
10	130	65	190	100	305	215
12	185	95	255	155	375	260
14	195	110	310	190	425	385
16	215	170	370	300	500	540
18	250	195	430	365	580	600
20	300	220	510	465	750	740
24	400	305	730	660	980	1050

Tray Supports, Etc.—The nomagraphs in Figure 2 are used in the following manner for determination of total weight of the required number of (1) tray supports and downflow plates and, (2) insulation rings.

Assume that the vessel under consideration (3½ feet in diameter × 30 feet high) requires seven trays and also seven insulation rings.

(a) On the nomagraph for tray supports use a straight edge to connect the 3½-foot point on the scale marked "Diameter" with the point marked 7 on the scale marked "Number Required." The total weight for the seven tray supports and downflow plates can be read off the weight scale, at the point of intersection with the straight edge as 560 pounds.

(b) The same procedure is followed on the nomagraph for insulation rings.

Skirt—The weight of the skirt can be determined by one of two methods:

1. Separately, as a cylinder of its own thickness and length, or

2. With the vessel shell by inclusion as part of the TL-TL dimension, converting its thinner wall into equivalent feet of the heavier cylinder.

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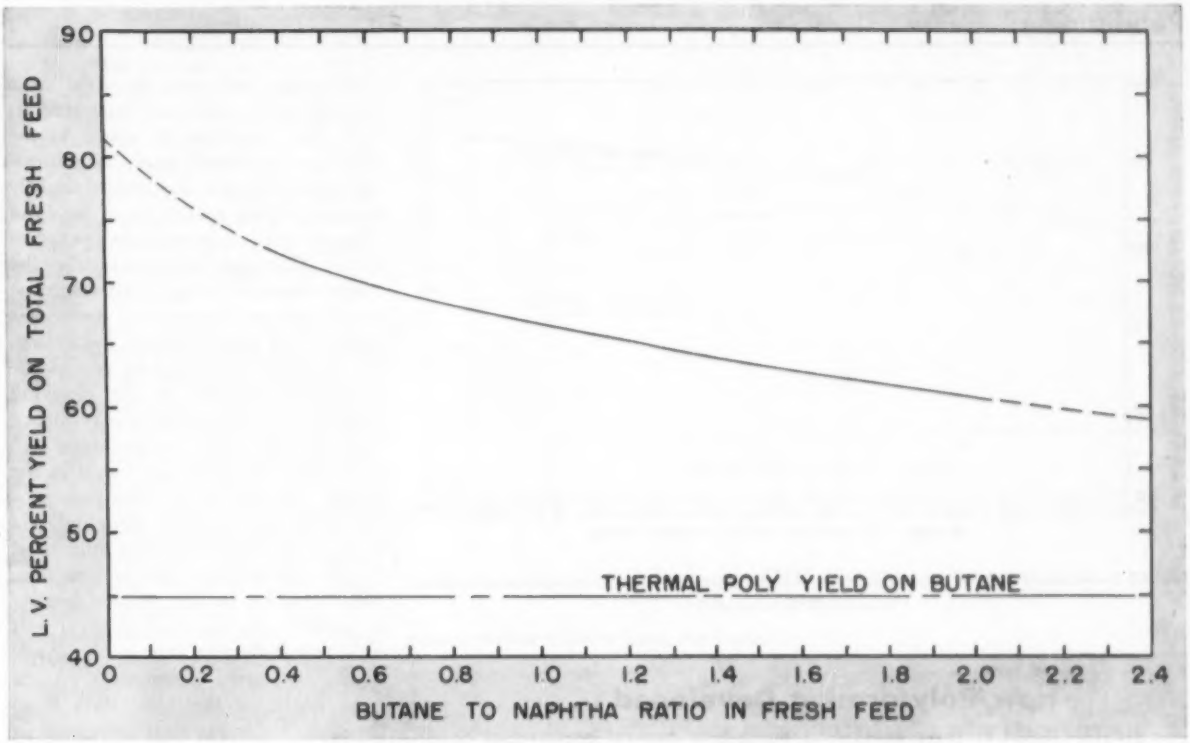

FIGURE 1—Percent yield of polyformate versus butane/naphtha ratio.

Still Polyforming in Your Plant?

These economic studies show effect of butane price and butane/naphtha ratio in feed stock on profits.

D. F. Cameron, R. T. Weaver,
Continental Oil Company
Ponca City, Oklahoma

LONG SUPPLIES of butane and the ever increasing octane number have resulted in some new interest in polyforming in the past several years. As shown in this study on one of Continental's Oil Company's units, two major factors influence the profitability of the process: the yield structure as a function of butane to naphtha ratio in the feed (if severity and furnace feed rate are held constant) and the market price of butane.

TABLE 1
Yields and Operating Conditions
Polyforming

	Thermal Poly Case I	POLYFORMING Case II	Case III	Case IV
Naphtha feed rate, bpd	None	1,570	765	505
Butane feed rate, bpd	1,200	630	925	1,010
Butane/naphtha ratio in fresh feed	....	.4	1.2	2.0
Furnace feed rate, bpd	8,400	8,400	8,400	8,400
Butane/naphtha ratio in furnace feed	....	4.3	10.0	15.6
Radiant coil outlet, Temperature, F	1,010	990	987	995
Soaking coil outlet, Temperature, F	1,015	989	983	995
Pressure, psig	1,520	1,600	1,550	1,540
Yields, Fuel gas (FOE)	381	438	324	361
Polyformate	540	1,583	1,100	922
Heavy polymer	3	70	60	15
Octane Numbers, Naphtha feed F-1 clear	....	44.0	44.0	44.0
Polyformate 7.5-lb. Rvp F-1 + 3 cc	94.0 (approx.)	93.6	94.0	93.7

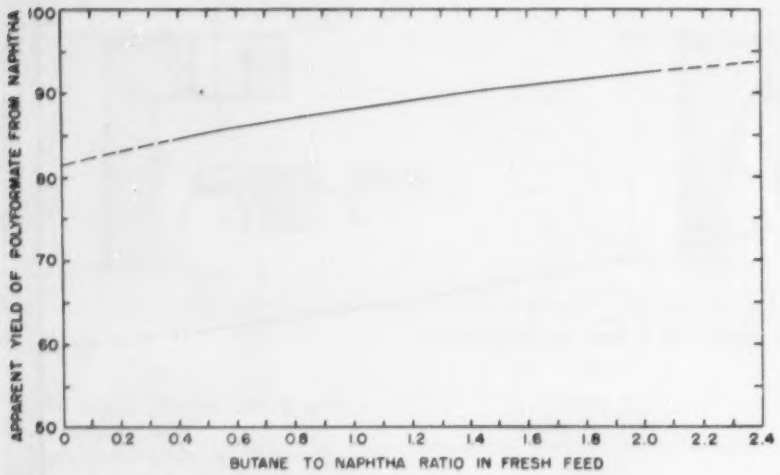

FIGURE 2—Apparent yield of polyformate from naphtha increases with increasing butane/naphtha ratio.

How Polyforming Developed . . .

HISTORICALLY, the process first came into general commercial application in prewar years of the late 1930's. Parallel development of the basic process is credited to Gulf and Phillips who joined to license the process.[1] During the war, only relatively minor use was made of the process since refining emphasis was not on motor gasoline production and other uses for butane existed. About 1947 the competitive octane situation and the availability of butane brought the process into prominence again. Although the advent of the newer catalytic reforming process has eliminated the construction of new polyforming units, the operation of existing polyforming equipment can be very attractive economically.

Basically the polyforming process is an outgrowth of the thermal polymerization operation in which butanes and, occasionally, propanes are cracked at high temperatures and pressures. The olefins produced combine at the conditions of the reaction to form a polymer of high octane number. Normally the unreacted portions of the feed are recycled until the ultimate products from the operation are dry gas and polymer. In polyforming, naphtha is added to the feed to the furnace, and thermal reforming takes place in the presence of the light hydrocarbons. The presence of the propanes and butanes has two effects. First, they affect the equilibrium of the reforming reaction, reducing the formation of light hydrocarbons and improving the yield of reformate. Second, they lower the dew point of the mixture in the furnace, preventing the condensation of tars in the furnace coil and the resultant formation of coke at this point despite the severe cracking conditions.

There is a second type of operation classified as polyforming in which no light hydrocarbon as such is fed to the unit and only the propane and butane produced from the thermal decomposition of the naphtha feed are available for recycle.[5] Our data and experience are, however, limited to the operation in which butane is a feed and therefore restricted to the high ratio of light hydrocarbon/naphtha in the furnace which results from such an operation.

The simplified flow diagram of the unit (Figure 4) shows the physical equipment involved. The unit consists of a cracking furnace, a partial stabilizer to remove the bulk of the light hydrocarbons from the furnace effluent, a debutanizer to complete the stabilization of the polymers, and a rerun tower to separate the polymers into heavy and light fractions. An absorber-stripper combination which utilizes the fresh naphtha feed as a lean oil is included to permit the removal of dry gas from the system without excessive loss of butane.

Conoco's unit was designed as a thermal poly unit and operated as such for a number of years. As the need for increased naphtha reforming arose, the unit was revised slightly and increasing quantities of naphtha charged until at present the operation varies through approximately the range shown in Table 1. Although the temperatures shown may seem less severe than some thermal reforming, the inclusion of a soaking coil in the convection section of the cracking furnace greatly increases the residence time at this high temperature. No noticeable variation was found in the octane number of the reformate produced. Other cracking data indicate that octane number is most influenced by the temperature of the reaction. The variation in the ratio of butane to naphtha in the feed is the result of seasonal fluctuations in the availability and price of butane.

In analyzing the yield data from the unit, including that presented in Table 1, the plot shown in Figure 1 was found useful. Here the percentage yield of polyformate based on total naphtha plus butanes is plotted against the ratio of butane to naphtha in the feed to the unit. In the unit under study, this ratio is directly related to the light hydrocarbon to naphtha ratio in the furnace feed, hence has a sound theoretical basis. A similar relationship will exist between the two ratios in any unit operating at constant severity and fixed furnace feed rate and yielding only dry gas and naphtha as products. Figure 2 shows that the yield attributable to the naphtha increases as the butane-naphtha ratio in the fresh feed increases.

Based on the yield data of Table 1 the economics of polyforming have been developed in Table 2. Instead of assigning a value to the naphtha feed and calculating the profit from polyforming, values were assigned to all other products and the value of naphtha obtained by difference. Credits for the polyforming operation are of course the values of the products. The unit prices of these products were established by deducting the operating expense of further refining and TEL. costs from the market prices of fully refined products. The debits of the operation are the value of the butane feed to the process and the operating

expense of the unit. In addition to the more obvious costs of operation, the fact that the unit could be operated as a thermal polymerization unit must be considered. Butane as charge to the unit in thermal poly operation is worth approximately 5.4 cents per gallon. If the market value of butane is less than this, the possible earnings of the unit operating as a butane cracker must be debited to the polyforming operation.

Two major factors influence the profitability of polyforming: first, the yield structure which has been shown to be a function of butane to naphtha ratio in the feed if severity and furnace feed rate are held constant and, second, the market price of butane. Cases II, III, and IV have been carried throughout Table 2 to show the effect of variations in butane to naphtha ratio. The effect of butane price has been demonstrated by repeating the economic evaluations at several different butane prices. To prevent the tables from becoming cumbersome, only the calculations for butane prices of 4, 5, and 6 cents per gallon are shown.

The value of naphtha as polyforming feed stock is plotted versus the

Meet the Authors

D. F. CAMERON has devoted most of his time with Continental Oil Company to process-design work and economic evaluation, with much of his efforts directed toward modernizing and enlarging existing units. Promoted to senior process engineer early this year, Cameron joined Conoco in 1951 after completing graduate studies at the University of Tulsa. Before entering the university, he was with Tide Water Associated Oil Company, which he joined in the Development department at Bayonne, N. J., following graduation from Rensselaer Polytechnic Institute in 1947.

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R. T. WEAVER, who has been with Continental since last summer, now is on military leave to the Army which he entered in May. A chemical engineering graduate from Kansas State College, he joined Conoco as a process engineer at the refinery in Ponca City after graduation. During his senior year in college, Weaver was holder of the Coleman scholarship for engineering students.

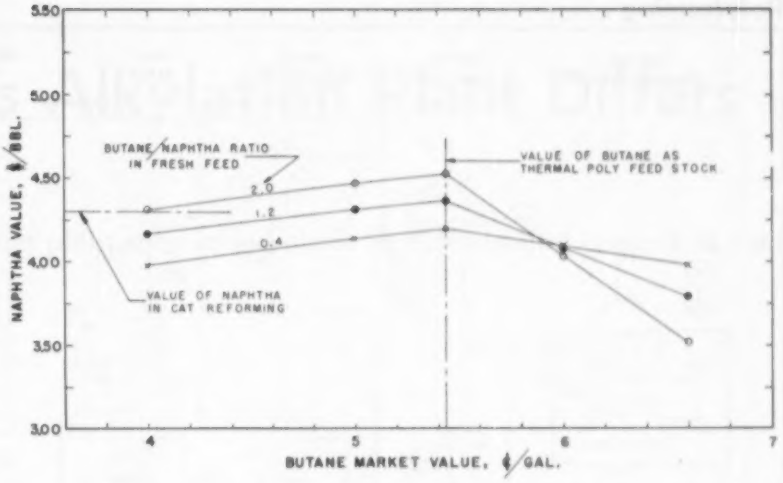

FIGURE 3—Plot shows when butane should be sold and when it should go to thermal poly.

TABLE 2

Polyforming Economics

Butane Market Value 4 Cents Per Gallon

	Unit Value $/Bbl.	Thermal Poly. Case I		Case II		Case III		Case IV	
		Bpd	$/Day	Bpd	$/Day	Bpd	$/Day	Bpd	$/Day
Credits:									
Fuel gas (FOE)	1.35	(381)	514	(438)	591	(324)	437	(361)	487
Polyformate	4.87	540	2,630	1,583	7,709	1,100	5,357	922	4,490
Heavy polymer	1.90	3	6	70	133	40	76	15	29
Total Credits	....	....	3,150	....	8,433	....	5,870	....	5,006
Debits:									
Butane	1.68	1,200	2,016	630	1,058	925	1,554	1,010	1,697
Operating expense	$.05/Bbl. furnace feed	8,400	420	8,400	420	8,400	420	8,400	420
Earnings of unit in thermal poly operation (Case I net earnings)	....	....	....	....	714	....	714	....	714
Total Debits	....	....	2,436	....	2,192	....	2,688	....	2,831
Credits minus Debits	....	....	714*	....	6,241	....	3,182	....	2,175
Naphtha charge, bpd	....	....	....	1,570	....	765	....	505	....
Naphtha value, $/Bbl.	....	....	....	....	3.98	....	4.16	....	4.30

* Value of butane as thermal poly feed stock $= \frac{3{,}150 - 420}{1{,}200} = \$2.28$ per barrel.

Butane Market Value 5 Cents Per Gallon

Credits:									
Fuel gas (FOE)	1.35	(381)	514	(438)	591	(324)	437	(361)	487
Polyformate	4.87	540	2,630	1,583	7,709	1,100	922	5,357	4,490
Heavy polymer	3.15	3	6	70	133	40	76	15	29
Total Credits	....	....	3,150	....	8,433	....	5,870	....	5,006
Debits:									
Butane	2.10	1,200	2,520	630	1,323	925	1,942	1,010	2,121
Operating expense	$.05/Bbl. furnace feed	8,400	420	8,400	420	8,400	420	8,400	420
Earnings of unit in thermal poly operation (Case I net earnings)	....	....	....	....	210	....	210	....	210
Total Debits	....	....	2,940	....	1,953	....	2,572	....	2,751
Credits minus Debits	....	....	210	....	6,480	....	3,298	....	2,255
Naphtha charge, bpd	....	....	....	1,570	....	765	....	505	....
Naphtha value, $/Bbl.	....	....	....	....	4.13	....	4.31	....	4.47

Butane Market Value 6 Cents Per Gallon

Credits:									
Fuel gas (FOE)	1.35	....	....	(438)	591	(324)	437	(361)	487
Polyformate	4.87	....	....	1,583	7,709	1,100	5,357	922	4,490
Heavy polymer	3.15	....	....	10	133	40	76	15	29
Total Credits	....	....	....	....	8,433	....	5,870	....	5,006
Debits:									
Butane	2.52*	....	....	630	1,588	925	2,331	1,010	2,545
Operating expense	$.05/Bbl. furnace feed	....	....	8,400	420	8,400	420	8,400	420
Total Debits	....	....	....	....	2,008	....	2,751	....	2,965
Credits minus Debits	....	....	....	....	6,425	....	3,119	....	2,041
Naphtha charge, bpd	....	....	....	1,570	....	765	....	505	....
Naphtha value, $/Bbl.	....	....	....	....	4.09	....	4.08	....	4.04

* At this butane price, thermal polymerization is not profitable.

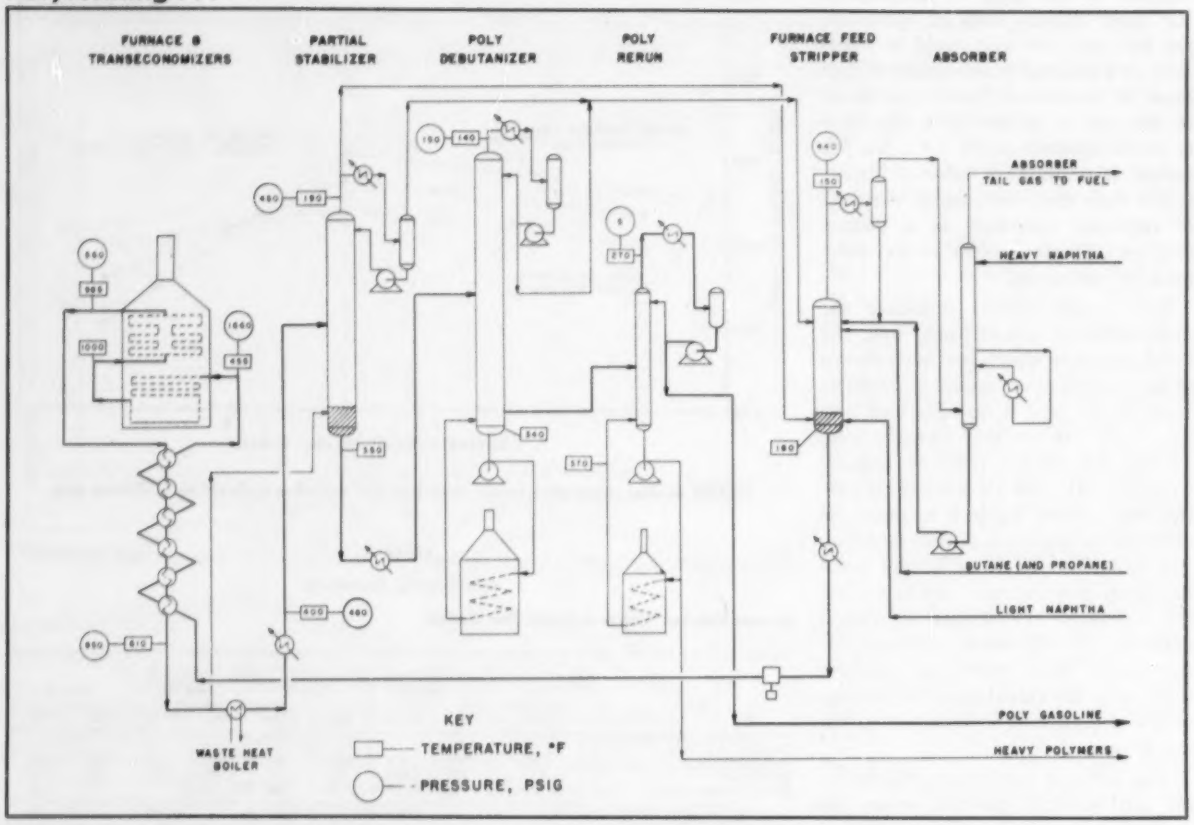

FIGURE 4—Flow diagram for polyformer at Conoco's Wichita Falls refinery: Absorber-stripper combination utilizes fresh naphtha feed to prevent butane loss.

market value of butane in Figure 3. The ratio of butane to naphtha in the feed to the unit is incorporated as a parameter. A discussion of Figure 3 divides itself naturally into two parts, the section of the plot in which it is economically attractive to thermal poly butane and the section in which butane should be sold as such.

At butane prices of approximately 5.4 cents per gallon or less, the increase in the value of butane consumed by the polyforming process is more than offset by the increased sales price of butane displaced by the naphtha feed, hence the curve rises. As would be expected in this portion of the curve, the improvement in yields resulting from increased butane/naphtha ratio raises the value of the naphtha.

After the market price of butane exceeds 5.4 cents per gallon, thermal polymerization is no longer a profitable operation; and there is no debit for the butane replaced by naphtha. Under these conditions, increasing value of butane consumed in the polyforming operation decreases the earnings of polyforming, hence the value of the naphtha. This effect becomes more pronounced at the higher butane to naphtha ratios until, at a butane value of about 6 cents per gallon, the economics indicate that, despite the improved yield structure on the naphtha, butane feed rates should be cut to reduce unprofitable destruction of butane.

A value of this same naphtha as feed stock to a catalytic reformer producing 94 F-1 + 3 cc. octane number reformate was estimated and plotted in Figure 3 for comparative purposes. Normally the polyforming process is less attractive than catalytic reforming; however, at a butane price of about 5 cents per gallon and at high butane/naphtha ratios, the polyforming unit would be operated in preference to a cat reformer. Polyforming as it is known today is not capable of producing octane numbers much above 94 F-1 + 3 cc., hence cannot compete with catalytic reforming if octane numbers move much higher.

In conclusion it should be said that the curves presented have many limitations. On an absolute basis they apply to only one unit operating at a given severity level with a specific naphtha feed. The economic evaluation curve involves assumptions of unit prices which actually vary from time to time and place to place. The prices of refined products are, however, normally interrelated, and units have common operating characteristics so that the *trends* shown by these data are generally useful.

Original presentation was before the regional meeting of Western Petroleum Refiners Association, Big Spring, Texas, May 27, 1955.

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ACKNOWLEDGMENT

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How Cosden's Alkylation Plant Differs

New HF Alkylation plant uses mixed olefin feed, horizontal contactors, and product defluorination.

A. R. Orr,
Cosden Petroleum Corporation
Big Spring, Texas

COSDEN Petroleum Corporation has been on stream for one year with its new UOP designed and licensed HF Alkylation plant. The Cosden HF plant differs radically from most of the earlier war-time plants. Cosden chose HF over sulfuric acid alkylation for two reasons:

(1) Disposal of spent acid from a sulfuric acid plant at Big Spring appeared to be impossible and

(2) No economic means of regeneration was available at the time of selection.

The chemistry of HF Alkylation is straight forward, but mechanics of the process may be varied greatly. Alkylation of butylenes only has been the accepted standard for years in producing aviation alkylate of the 115/145 grade. Cosden departed from the usual in this case. By using a mixed olefin feed, volume of alkylate produced could be increased considerably using only the feed available from other refinery operations. The result was design and construction of a plant to process a mixed stream to produce the maximum volume of aviation alkylate. Table 1 shows a typical analysis of recent feed streams to the plant.

Insufficient iso-butane was available in the refinery; but nearby gasoline plants contracted to supply isobutane of 95 percent purity for the process. For blending of the finished aviation gasoline, toluene from Cosden's Platformer-Udex and iso-pentane (95 percent purity) from gasoline plants was made available.

Another variation from the normal HF plant was installation of horizontal contactors with mixers. In this plant there are two, operating in parallel, each with its own acid settler. They are manifolded, however, so that they may be operated individually or in series. Power for the mixers, which are mounted in the end, is supplied by direct drive 50-hp electric motors. A circulating seal oil system is used to seal the shaft of the mixer. The oil used is a regular paraffin type motor oil of which make-up rates have been fairly low.

Horizontal contactors made a less expensive installation than the usual vertical type primarily because of lower structure costs. The mixer hook-up had several features showing advantage over the older type: (1) less horsepower was required to produce mixing, (2) less load on the thrust bearing, (3) scale and sludge was less likely to accumulate around the shaft, (4) angle gears were not necessary, eliminating many of the maintenance problems of the vertical units. Figure 2 is a diagrammatic sketch of the horizontal contactor.

A third major change in the plant is location of the defluorinators. In this plant the alumina defluorinators are located following the deisobutanizer. This makes possible defluorination of only the product streams, reducing considerably the size of the equipment required. There have been no indications of harmful effects due to placing the defluorinators in the products stream.

The feed preparation section is made up of the equipment from the old phosphoric acid polymerization plant which was discontinued when the alkylation plant was built. Feed preparation consists of desulfurization and deethanization of the combined olefinic streams from the fluid cat-cracker and Dubbs thermal cracker. Desulfurization is accomplished through use of a diethanolamine scrubber for H_2S removal and a regenerative caustic system for mercaptan removal. Intermediate storage is in service between the feed preparation section and the alkylation plant proper. This storage consists of

Training the Operator

Several weeks before start-up time, the men who were to operate the plant were transferred to it to begin a program of training in operating techniques and safety procedures. Available literature from the manufacturers of HF acid and operating manuals of UOP were made available. These treated fully the operating techniques and safety programs recommended by UOP HF experienced personnel. Trips to operating HF plants were made so that the operators could observe for themselves the procedures involved. Officials believe the extra time and expense has paid off many fold.

TABLE 1
HF Alkylation Plant Feed Composition

COMPONENT	Volume Precent
Ethane	0.1
Propylene	14.9
Propane	10.3
Iso-Butane	18.8
Butylene	31.7
N-Butane	15.2
Iso-Pentane	3.6
N-Pentane	2.5
Amylene	2.9

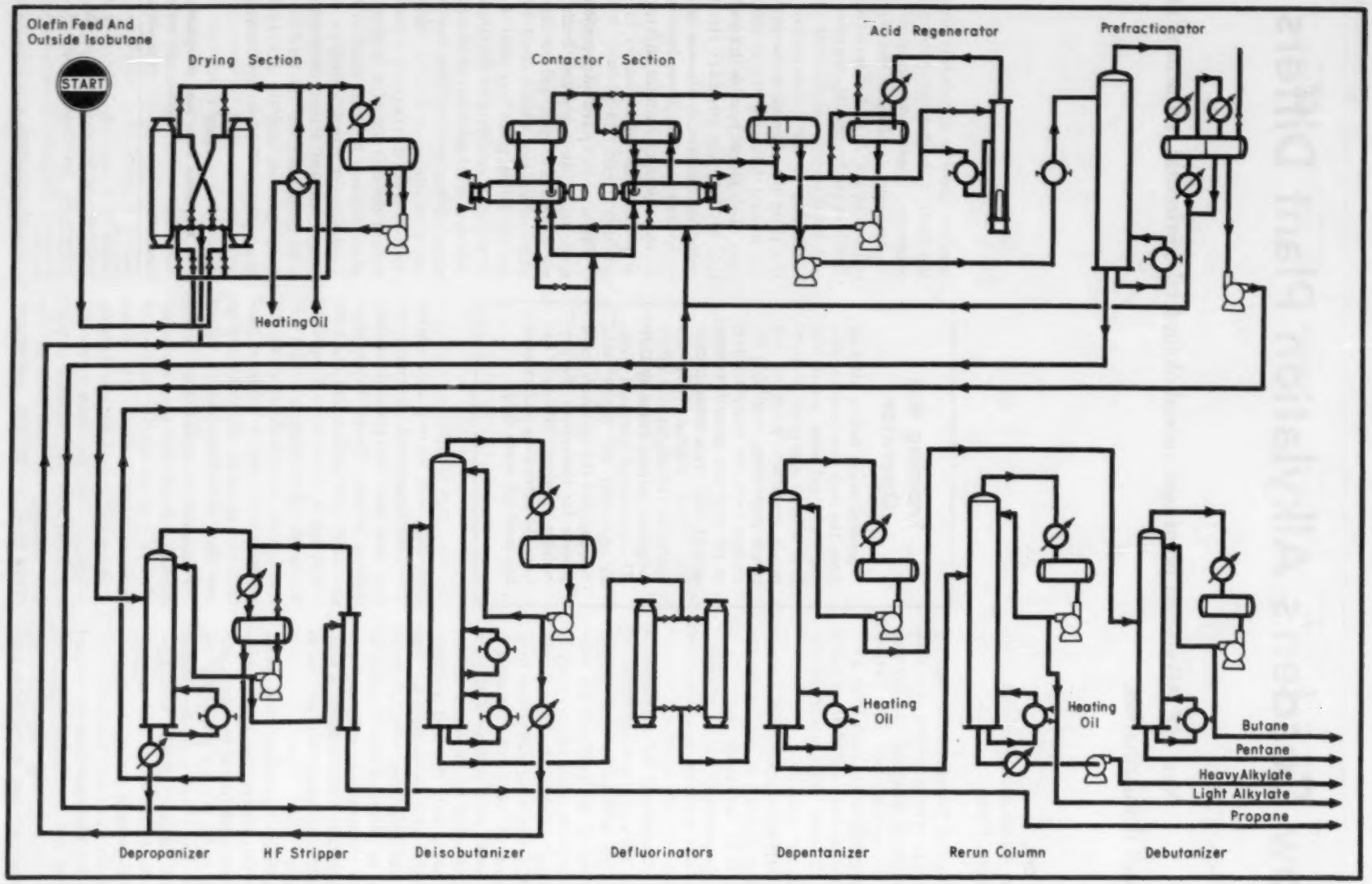


FIGURE 1—Flow diagram for alkylation unit: Alumina defluorinating towers follow the deisobutanizer.

a 2500-barrel capacity sphere and approximately 50,000 barrels of underground storage capacity.

Cooling water for the entire plant is supplied from an 8000 gpm induced draft cooling tower designed for a 5° approach. Contactor effluent temperatures in hot weather range from 80 to 90 F. In cool weather, temperatures run somewhat lower. By being able to operate at temperatures in this range, the use of refrigeration is unnecessary.

Reboiler heat in the plant is supplied from three sources: (1) 50-pound exhaust steam from the cooling water turbines (2) 170-pound plant steam from the boiler plant, (3) reboiler heating oil from a closed circuit system using a gas fired heater. Another unusual feature of the plant involves two reboilers on the deisobutanizer, the top one taking liquid from tray number 45, and circulating through a reboiler heated by 50-pound steam; while the additional heat and temperature is applied using the 170-pound steam in the bottom reboiler.

Figure 1 is a schematic flow diagram of the plant.

Products consist of propane, butane, pentanes, light alkylate and heavy alkylate. Propane is the bottom product from the HF stripper. Product control is maintained through use of the mercury freeze test. To be certain of an acid free, dry propane stream, the propane is caustic scrubbed and then processed through a dewatering column. In the original plant flow pattern, butane was the overhead product from the vessel shown on Figure 1 as the depentanizer. As more amylenes were made available, the original polymerization plant debutanizer was placed in service to make the split between butane and pentane. Control of the butane composition is through use of atmospheric boilaways with daily checks by infra-red analysis. Average composition of the butane product stream is less than 1 percent iso-butane and 99 percent N-butane. The pentanes consist of iso-pentane and n-pentane all of which is returned to the motor fuel pool. The light alkylate serves as base stock for 115/145 performance number aviation gasoline and heavy alkylate is added to motor fuel.

Table 2 is a typical inspection report of light alkylate and finished avgas blends.

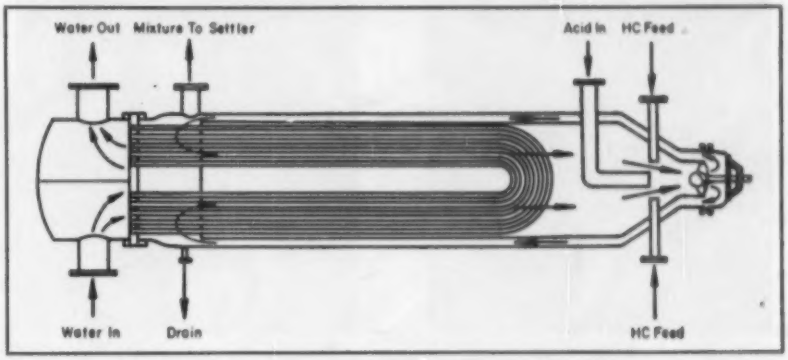


FIGURE 2—Horizontal contactors: A departure from standard practice.

A most important and interesting feature is the low acid consumption—even lower than the early estimate of 0.25 pound per barrel of alkylate. An average over the past seven months has been 0.19 pound per barrel of alkylate. This low acid consumption may be attributed to three major factors: (1) high isobutane to olefin ratio (approximately 9/1), (2) high acid purity of the circulating acid streams (over 90 percent) through regeneration, (3) location of the alumina defluorinating towers following the deisobutanizer thereby reducing the amount of fluorides to contact the alumina. The isobutane recycle stream from the deisobutanizer overhead is checked by the plant operators frequently using the boilaway system. Each day an infra-red check is also run to assist in control of the stream.

Results of the past year have been gratifying. The plant was designed to process 2413 barrels per stream day of mixed olefin feed to produce 2064 barrels per stream day of light alkylate. In capacity tests over 3000 barrels per stream day of olefin feed has been charged with no operating difficulties and with the same good product quality. The high quality of the light alkylate has been especially pleasing since propylene and amylene alkylate can be expected to downgrade performance numbers. Finally, no one has suffered an acid burn in the plant.

Original presentation was before the Western Petroleum Refiners Association regional meeting at Big Spring, Texas, May 28, 1955. ##

TABLE 2

Typical Inspection of Light Alkylate and Aviation Gasoline Blends

	Light Alkylate	Avgas* 115/145
Gravity, °API	71.0	70.6
Vapor Pressure, Reid, psi	3.0	6.7
ASTM Distillation, °F.:		
IBP	138	104
10 percent	182	141
20 percent	192	160
30 percent	200	176
50 percent	210	204
70 percent	218	216
90 percent	238	236
End Point	334	314
Recovery, percent	99	98
Residue, percent	0.4	0.5
Performance Numbers:		
F-3, + 4.6 ml. TEL	119–120	120
F-4, + 4.6 ml. TEL	140–142	134.4

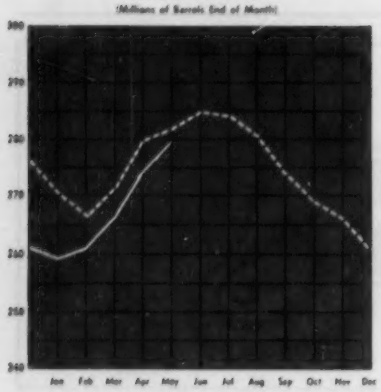
* Avgas blends made up of approximately **77.5** volume percent light alkylate, **6.0** volume percent nitration grade toluene, and **16.5** volume percent isopentane (95 percent purity).

Meet the Author

ALLEN R. ORR, who now is chief process engineer with Cosden Petroleum Corporation, has been engaged in process work since he started with the Big Spring, Texas, refining company in 1950. He joined the company as a process engineer following graduation from Texas Technological College where he received a B.S. degree in chemical engineering. In addition to his duties as chief engineer, which requires considerable attention to work with lighter hydrocarbons in polymerization and alkylation processes, Orr doubles as foreman of the refinery's fluid catalytic cracking unit.

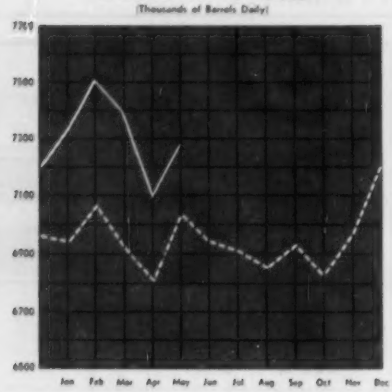
CRUDE STOCKS

(Millions of Barrels End of Month)



CRUDE RUNS TO STILLS

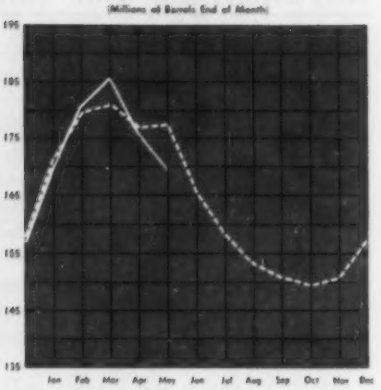
(Thousands of Barrels Daily)



1954 1955

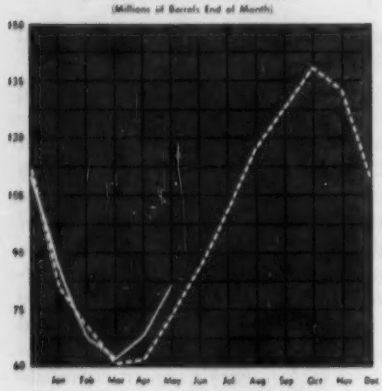
GASOLINE STOCKS

(Millions of Barrels End of Month)



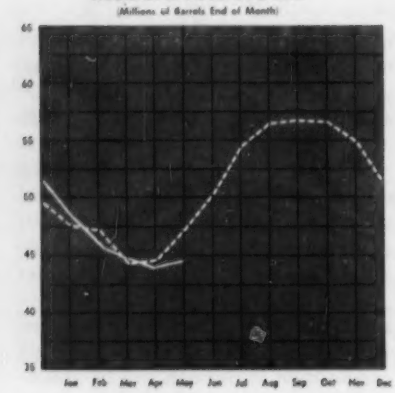
DISTILLATE FUEL STOCKS

(Millions of Barrels End of Month)



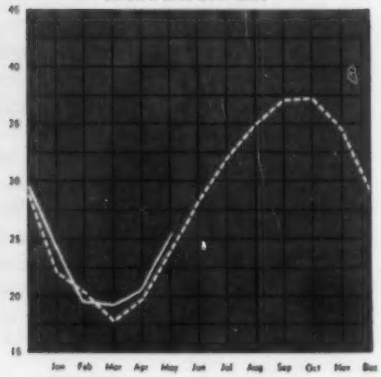
RESIDUAL FUEL STOCKS

(Millions of Barrels End of Month)



KEROSINE STOCKS

(Millions of Barrels End of Month)



Taking Stock

Cecil W. Smith,
Economics Editor

- Refinery thruput rates near peak
- Gasoline stocks under year ago
- Fuel oil inventories building

MONTH	CRUDE OIL			GASOLINE		KEROSINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1953:													
May	6,390	7,002	280,308	3,366	156,415	327	24,307	1,400	73,706	1,197	41,795	703	1,096
June	6,595	7,081	283,715	3,467	146,196	326	27,659	1,462	84,504	1,238	43,801	707	1,050
July	6,603	7,103	284,976	3,583	143,916	321	31,143	1,441	102,258	1,224	47,530	629	950
August	6,583	7,163	285,352	3,592	146,050	321	35,711	1,437	119,542	1,222	50,007	672	946
September	6,557	7,023	289,614	3,521	144,184	330	37,280	1,448	126,709	1,203	50,516	692	1,013
October	6,262	6,872	287,541	3,437	144,495	355	38,161	1,462	135,409	1,184	50,820	639	990
November	6,277	6,987	283,021	3,528	150,747	354	36,271	1,463	133,381	1,223	51,267	648	1,120
December	6,238	6,964	276,676	3,628	159,949	378	29,070	1,441	111,944	1,247	49,370	598	1,121
1954:													
January	6,240	6,947	270,811	3,431	171,704	390	22,013	1,467	81,044	1,271	47,474	617	1,143
February	6,379	7,068	266,918	3,476	179,950	412	20,183	1,545	70,390	1,241	47,119	621	1,144
March	6,507	6,923	271,867	3,375	181,297	353	17,533	1,458	60,270	1,168	44,249	654	1,088
April	6,615	6,811	280,310	3,404	177,006	322	19,656	1,374	61,721	1,140	44,362	574	950
May	6,471	7,038	282,250	3,482	177,606	302	23,892	1,372	73,581	1,149	47,009	706	1,021
June	6,500	6,947	285,155	3,483	165,404	306	28,184	1,399	86,325	1,123	50,216	624	999
July	6,242	6,916	284,894	3,480	158,010	295	31,953	1,416	101,657	1,089	54,365	724	1,038
August	6,168	6,862	281,043	3,492	153,168	302	34,949	1,453	117,579	1,069	56,332	664	966
September	6,151	6,939	274,608	3,511	150,916	301	37,099	1,514	128,061	1,086	56,702	672	999
October	6,135	6,834	269,442	3,457	149,661	310	37,140	1,545	139,128	1,066	56,541	642	1,065
November	6,346	6,975	264,566	3,530	150,604	354	34,547	1,622	133,886	1,120	54,891	636	1,104
December	6,394	7,238	258,385	3,605	155,400	381	27,826	1,668	108,144	1,187	52,105	729	1,301
1955:													
January	6,761	7,379	260,156	3,639	169,562	409	23,266	1,740	86,692	1,235	49,457	739	1,348
February	6,835	7,549	258,630	3,655	181,643	374	18,291	1,847	68,513	1,239	46,042	751	1,379
March	6,886	7,374	264,430	3,543	183,972	357	18,187	1,703	62,457	1,185	44,970	742	1,319
April	6,887	7,136	275,232	3,502	175,601	312	21,486	1,534	70,139	1,110	43,838	697	1,123
May	6,664	7,276	279,812	3,500	169,150	305	25,700	1,514	81,981	1,116	44,243	746	1,118
Week Ended:													
6-17-55	6,626	7,520	276,692	3,648	165,285	314	28,435	1,601	91,269	1,158	45,684	845	1,202
6-18-54	6,495	6,893	277,673	3,370	168,983	312	25,942	1,327	79,402	1,153	49,772	655	974

Source: Data for last two months from API; prior monthly data from Bureau of Mines. Data in thousands of barrels.

REVERE COPPER
ideal for distillation columns

These photographs show three distillation columns fabricated by American Copper & Brass Works, Cincinnati 2, Ohio, for a customer in a foreign country. They are made of Revere Copper Sheets and Circles. All told, 4608 pounds of copper were required. The columns will be used to distill high-proof alcohol, either beverage or industrial.

Longitudinal seams were welded. Flanges were produced by simply turning the metal over to the required dimension. Copper, you see, is extremely easy to work. In addition, it does not react with alcohol and a wide variety of other liquids and gases. Copper also can be quickly and economically welded by modern methods, and if you wish, the Revere Technical Advisory Service will be glad to show you how to do a fast and sound welding job on copper sheet and plate. See the nearest Revere Sales Office.

Two views of three copper distillation columns by American Copper & Brass Works, Cincinnati. The large holes will be closed by removable plates, for inspection and cleaning.

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COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

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Valuable Reading Ahead

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New Books PAGE 172

KEEP GOING for capsule digests of books that will interest you.

How To Do It PAGE 174

KEEP GOING for some quick ideas that will mean money in your pocket, greater efficiency in your plant.

Who's Building PAGE 183

KEEP GOING for a rapid-fire summary of construction activity in our mushrooming industry along with a quarterly "boxscore" of building projects.

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Heard at Meetings PAGE 278

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Suppliers' Notes PAGE 281

KEEP GOING for a glimpse at personalities in the supply industry.

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KEEP GOING for a fast description of the best in new mechanical developments.

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Chemical and Petrochemical Plants

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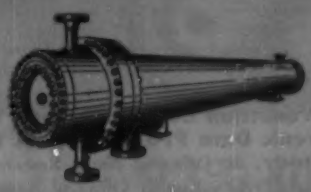
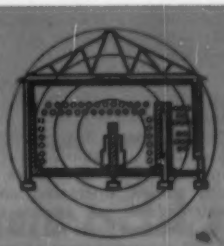
maximum return for



Manufacture of Heat Transfer Equipment
(Heat Exchanger Division)



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your capital investment!

In the past half century Lummus has designed, engineered and constructed over 700 major installations throughout the world. The excellent operating records of these plants indicate that the coordinated directing of a project from idea to startup is the best possible guarantee of a profitable investment. Our staff and facilities can complement your own – on your next project.

The Lummus Company, 385 Madison Ave., New York 17, N. Y. *Engineering and Sales Offices:* New York, Houston, Montreal, London, Bombay, Paris, The Hague. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pa. *Fabricated Piping Plant:* East Chicago, Ind.

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DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

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Reviewing New Books . . .

Speak to the Earth, by Max Miller. The book, written by the author of *I Cover the Waterfront,* explains exploration, drilling, production, transportation, refining, and marketing. In taking up these present operations, Max Miller projects from the prehistoric to the future, and in so doing he spins a truly fascinating real-life tale about oil and its people.

About these people the author says, "After these oilmen have created something revolutionary for us, instead of resting on their achievements or taking time out to catch their respective breaths, they are already starting on something else—if for no other reason than to try to outdistance their competitors."

Before starting this trip to meet and talk with people and gather facts about the oil business, Max Miller had little knowledge of the oil industry. He believes that those of us who were not born on an oil derrick or who did not have a driller for a father or relative working in a refinery still have old boyhood notions about oil.

"Even now I can hear my mother use the phrase, 'some rich oilman.' She probably never saw an oilman in her life nor had a chance to realize that a wildcatter could be as broke as we were," the author points out.

In this—his first book about the oil industry, the author sums up his impressions of this dynamic business in this manner: "Not until our own generation did we have an inkling of how this oil—this petroleum—was to transform our lives. The furor, the competition, the great rivalries, the quest for more and more inventions in the petroleum field—all these are still underway, and we are in the midst of them."
(Appleton-Century-Crofts, Inc., $3.75.)

Pipe Friction Manual, The Hydraulic Institute. Material in this manual is an extension and rearrangement of the pipe-friction data contained in the earlier "Tentative Standards of The Hydraulic Institute —Pipe Friction." This data is based on the latest information available. The form of the manual follows a pattern developed from suggestions by readers of the earlier publication.

The manual includes a section demonstrating the mathematical calculations used in the construction of later charts. This is supplemented by complete tables of friction loss for water. Given also are tables of resistance coefficients for valves and fittings, 90-degree bends, diffusers and others. The tables of resistance coefficients include experimental data and show values in detail regarding size and type.

The charts showing the friction loss for incompressible flow of viscous fluids have been redrawn for greater clarity. Also included are three fold-in charts of friction factors with related data to permit the calculation of any fluid in any size or shape conduit.

With the combination of formuli, friction-loss moduli, friction-factor charts, roughness-factor charts, viscosity tables and related information, the manual is a complete and workable treatise. (The Hydraulic Institute, 122 East 42nd Street, New York 17, 87 pages, $1.75 in U. S., $1.85 for other countries.)

Modern Gas Analysis, by Paul W. Mullen. Gas analysis is a somewhat neglected area of the training schedule of the analytical chemist in spite of its increasing importance in scientific and industrial laboratories.

The manual is designed to serve as an introduction to the theory and practice of absorptiometric and instrumental gas analysis. It contains a brief survey of the theories upon which the general methods are based, a description of some commercially-available equipment, a grouping according to types of analytical methods, and a brief survey of advantages and disadvantages of each method.

It is designed to give the student and the industrial chemist who has only limited knowledge of the available methods of gas analysis an acquaintance with the entire field. (Interscience Publishers, 250 Fifth Avenue, New York 1, 364 pages, $5.50.)

Thermodynamic Properties of Methane-Nitrogen Mixtures, by O. T. Bloomer, B. E. Eakin, R. T. Ellington and D. C. Gami. Data required for computing the energy requirements of processes to separate nitrogen from natural gas by liquefaction and distillation are presented in this research bulletin.

Use of these data for calculation of the conditions and heat reuirements for selected separation cycles employing distillation is illustrated. Comparative energy reuirements, based on attainable compressor and expansion turbine efficiencies, for five cycles with varied operating conditions, are tabulated. Included among the illustrations are Mollier charts for nitrogen and methane, and a tempurature-entropy chart for methane. (Institute of Gas Technology, 17 West 34th Street, Technology Center, Chicago 16, 51 pages, $3.50.)

Industrial Engineering Terminology, The American Society of Mechanical Engineers. Preparation of this standard was started in 1948 by the ASMS Management division's Work Standardization Committee. In 1950, the International Committee on Scientific Management recognized the need for international standardization by setting up a subcommittee on management terminology which was to limit its initial efforts to English-speaking countries.

The result of these efforts is a handy 50-page compendium of 500 industrial engineering terms arranged in alphabetical order and running from the initial entry, "abnormal reading," through "written standard practice." Definititions are as brief as would be practicable and can be understood even by non-experts in the field.

Subjects range from elementary definitions, such as those for industrial engineering or for a standard itself, to an entire series of complex production terms. There are concise descriptions of the flow-process chart and simo chart, of the Gantt chart as well as the Gantt task and bonus plan, of job classification and evaluation, of process layout and work station. (The American Society of Mechanical Engineers, Order Department, 29 West 39th Street, New York 18, 50 pages, $1.50.)

Light Scattering in Fuels, Part 1, Preliminary Studies on Diesel Fuel Stability, a Naval Research Laboratory report. Measurements of the scattering of light by gum particles in petroleum fuels may become an effective method of predicting the behavior of fuels in extended storage, according to his report.

Although the problem of instability and incompatibility of petroleum fuels is one of increasing concern, there is no universally-accepted test for predicting instability of fuels from various sources and under varying conditions of storage. The Naval Research Laboratory conducted this investigation to attempt to devise a test method.

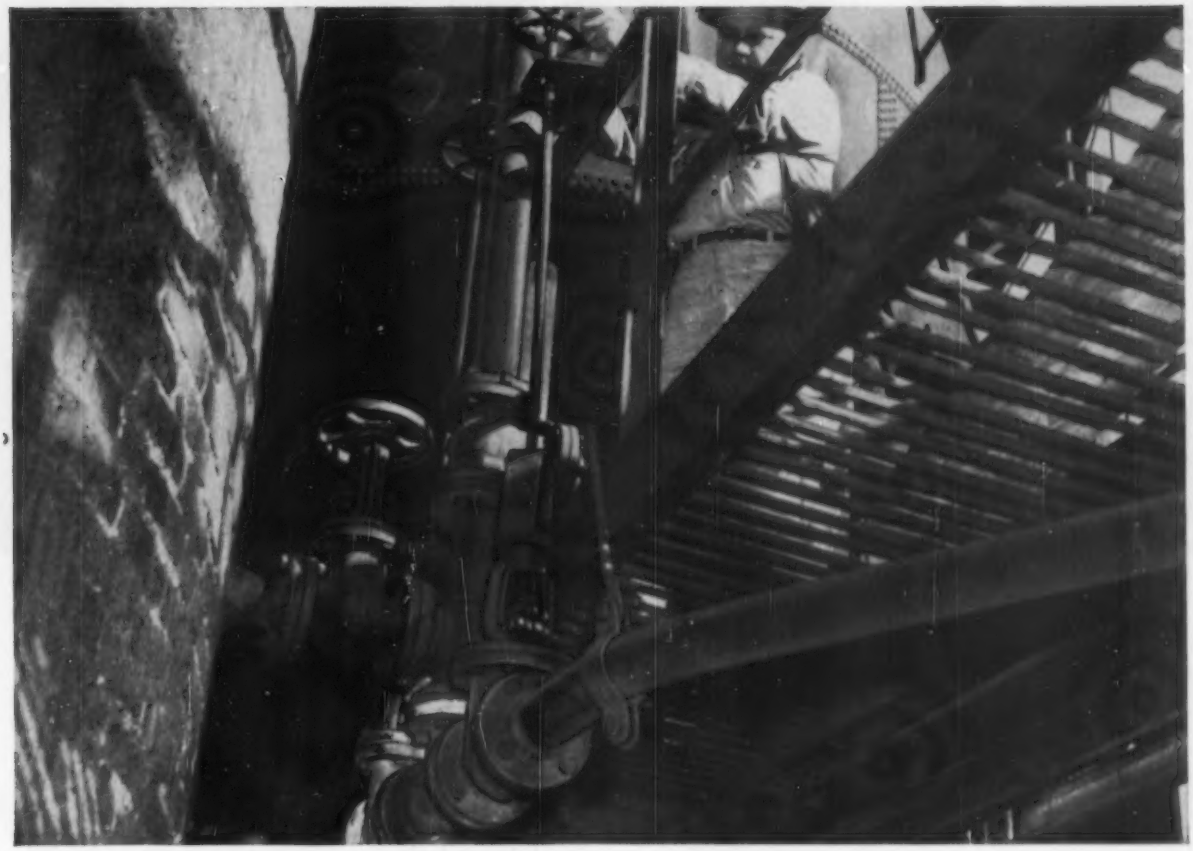
The gradual formation of insoluble gum is the element of fuel instability considered the most undesirable. The laboratory anticipated that gum would appear first as submicroscopic particles suspended in the fuel, and reasoned that because of the ability of small particles to scatter light, a technique based on this principle would detect the incipient formation of gum before it became evident by other means. A light scattering photometer was built for the study.

It was demonstrated that marked changes can be observed in presumably unstable fuels by the light scattering method when these fuels are aged for only a few days. Data obtained on the effect of two stability additives show that, on aging, fuels containing these additives develop less light scattering than fuels without the additives, indicating that the light scattering method promises to be useful in the investigation of stability additives. (Office of Technical Services, U. S. Department of Commerce, Washington 25, 50 cents.)

Production Control Through Electronic Data Processing: A Case Study, an Office of Naval Research report. Prepared under Office of Naval Research contract especially for management, the report requires no previous knowledge of electronic computers on the part of the reader. It describes and illustrates through case study the types of clerical operations machines can be expected to perform.

The report considers some of the major principles involved in applying new machines to business operations. To illustrate the application of these principles, it describes an in-plant research study, made at a medium size manufacturing plant, and the electronic data processing system which was prepared to meet the plant's production control requirements. Also included is a section on estimated costs, deliveries, and savings. (Office of Technical Services, Department of Commerce, Washington 25, 52 pages, $1.50.)

Protective Coatings for Metals, Second Edition, by R. M. Burns and W. W. Bradley. Greatly enlarged and almost entirely rewritten, this new edition presents recent information regarding the composition, properties and performance of both metallic and organic coatings. The book expanded sections on the evaluation of organic coatings, new chapters on corrosion inhibitors, chemical conversion coatings and sprayed metal coatings, together with explanations of such troublesome phenomena as "silver migration" and "metallic whiskers," and a wealth of other information. Many literature and patent references provide quick access to further and more detailed information. (Reinhold Publishing Corporation, 430 Park Avenue, New York 22, 643 pages, $12.)



93% sulphuric acid no problem for these Crane Valves

THE CASE HISTORY—No longer do petroleum processors have to be satisfied with unpredictable behavior of valves on sulphuric acid. It's still one of the toughest fluids to handle, but the "standards" for valve performance and durability are improving steadily.

For example, as shown above, a large midwestern refinery installed three Crane No. 475½ all-iron gates on 93% concentration sulphuric acid more than 2 years ago. These valves have been in continuous service on neutral agitator tanks, being operated about 3 times daily. Yet they have required no repairs whatsoever, and a recent check showed all three of these Crane valves in good working condition.

Making valves that do the job better has been Crane's main effort through 100 years of quality manufacturing. To thrifty buyers, Crane quality means greater dependability, lower ultimate cost. That's why more Crane valves are used than any other make. Crane Co., General Offices, Chicago 5, Ill. Branches and Wholesalers serving all industrial areas.

CRANE IRON BODY WEDGE GATE VALVES

Here are valves of unusual strength for their 200-pound W.O.G. rating. Body and bonnet are oval shaped, with extra metal where needed most. Their Crane-quality cast iron with highly engineered operating design makes these valves outstanding performers wherever they're used. A complete family to choose from. See your Crane Catalog or your Crane Representative.

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VALVES • FITTINGS • PIPE
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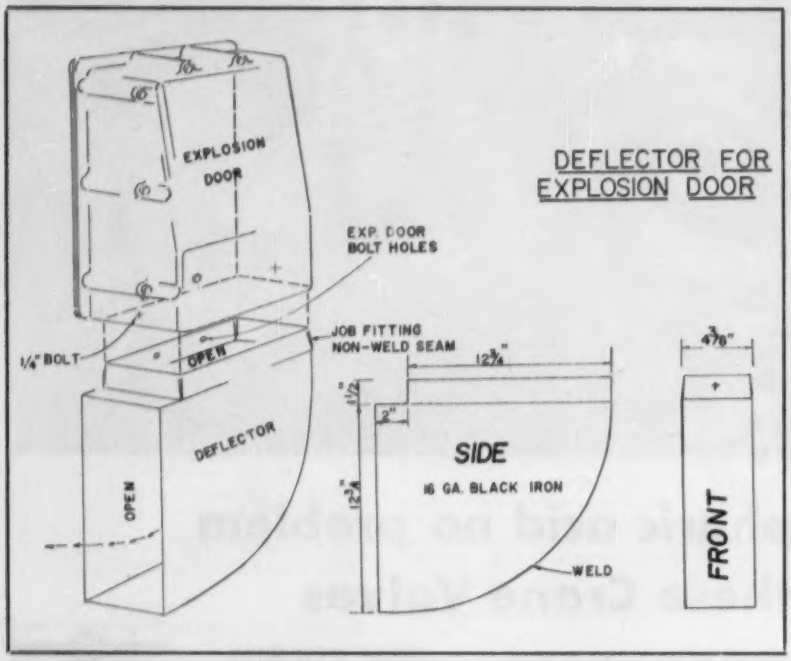
How to Do It . . .

$10 is paid for each accepted idea. Mail to Editor, Petroleum REFINER, P.O. Box 2608, Houston, Texas

Build Deflector for Explosion Door



A compressor engine explosion door deflector is a safety precaution in the event of engine explosions. The deflector can be installed on a compressor engine explosion door nearest the engine controls so that should a crank case explosion occur, the engine can be shut down without the danger of anyone being burned. It also gives protection to men working in the vicinity of the control.

The deflector, installed about eight inches from the floor, curtails oil splashing should there be an explosion.

The deflector is constructed of 10-gage sheet metal. Total cost of the device, including both labor and material, is approximately $8, a small sum to spend for such a safety device which will afford added protection to personnel working close to the compressor.

(More How to Do It on page 176.)

Truck Mounted Pile Driver Speeds Fence Repairing

Save time and money in repairing fences along the right-of-way by driving posts with this "pile driver" mounted on an ordinary winch truck. The unit can be made from scrap steel.

First, bolt H-beams across the bed of the truck and, inside them, run channel iron slides to the upright driving column. Make a clamp of a salvaged valve wheel to secure the horizontal beams in position for driving operations.

The vertical column consists of two I-beams joined by a welded cross member at the top. This cross member carries the pulley for lifting the driving weight as shown.

To drive a post, place it in the driving cap which rides down inside the vertical members. When the post is in position, take a slight strain on the line which is on the winch cat-head. The driving weight is lifted and the line is slacked off quickly allowing the weight to fall.

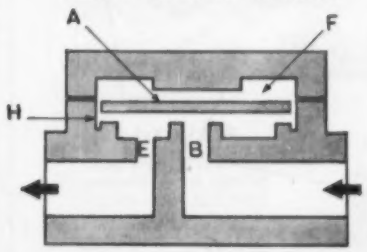
SARCO
Thermodynamic
STEAM TRAP

ACTUAL SIZE

this new trap virtually eliminates maintenance

SOLID STAINLESS STEEL DISC ACTS AS VALVE HEAD

HERE'S HOW IT WORKS!



Air and/or condensate raise valve seat disc A, discharge thru E. When steam follows, greater velocity causes it to strike body at H thus building up pressure in chamber F. This causes disc to seat, closing tube B. As pressure in F decreases by condensation, pressure in tube B raises disc and cycle is repeated.

The Sarco Thermodynamic Trap has proved successful on steam mains and separators; headers and soot blower pipes; engine and turbine stop valves, separators and casing drains; alternate heating and cooling applications.

2098-B

A solid stainless steel disc—practically indestructible—is the only moving part!

Most striking feature of the Sarco *Thermodynamic* Trap is its simple maintenance-free design. There's only one moving part – a solid stainless steel disc that practically lasts forever. There are no other moving parts to wear out or cause trouble.

Condensate, air and steam act directly on the disc valve which opens to discharge condensate and air – snaps shut to contain steam. There are no mechanical devices required to operate valve (see diagram at left). That means practically endless trouble-free operation.

Other advantages: small size, easy installation, not affected by shock or vibration, immunity to corrosive elements with all wearing parts stainless steel, same valve head and seat for all pressures to 600 psi and temperatures to 950° F.

Check these advantages to your own satisfaction at absolutely no cost. We'll send you a trap for trial. All you do is fill out the coupon and mail it in.

SARCO COMPANY, Inc.
Empire State Building, New York 1, N.Y.

MAIL COUPON TODAY FOR TRIAL

Sarco Company, Inc., Empire State Bldg., New York 1, N.Y.
Gentlemen: Please send me a Sarco Thermodynamic Trap for a 60-day trial, requirements as checked.
Size: ½"... ¾"... 1"... Operating Pressure:.....psi

For installation on.....

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FIRM_____

ADDRESS_____

CITY_____ STATE_____

now...

more effective and economical

ENTRAINMENT SEPARATION

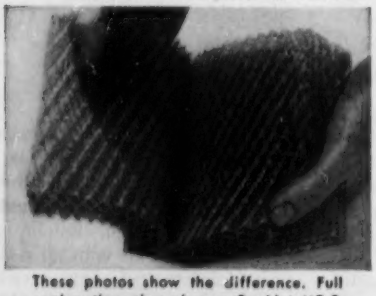
with the

NEW HI-THRUPUT HERRINGBONED MIST ELIMINATOR

Check these important points:

1. Half the pressure drop of Standard Mist Eliminator.
2. Safe operating limits – 10% to 12% higher velocity.
3. Entrainment removal practically 100% over wider operating range.
4. Three to four times longer on-stream life under coking conditions or where solids are present.
5. Lower cost – wires repositioned by Herringbone Fold*.

*U.S. Patent No. 2,565,846, Aug. 28, 1951



These photos show the difference. Full explanation given in our Booklet ME-5.

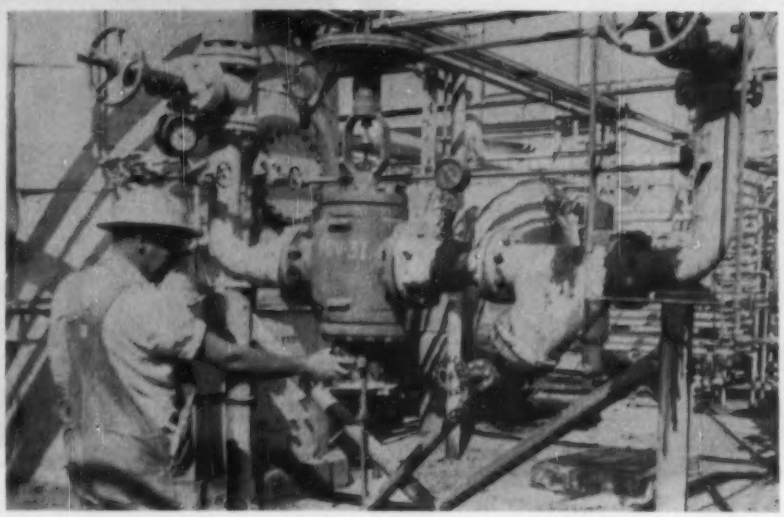
Send for Revealing Booklet ME-5. Learn how repositioning wires by patented Herringbone process and change in size and contour of mesh openings make this new Mist Eliminator more effective and economical.

METAL TEXTILE CORPORATION

Roselle, New Jersey

Metal Textile Corporation of Canada, Ltd., Hamilton, Ont.

How to Do It...



Simplify Flushing Crude De-Salter

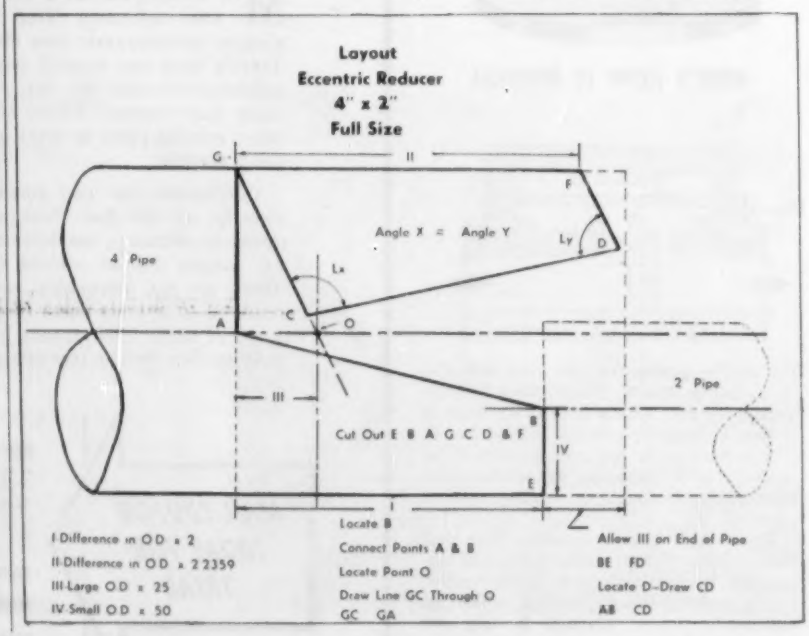
Where the crude oil enters the desalter, the control valve must be kept free of B. S. & W. and salt encrustations. A simple means of doing this is to connect a line to the bottom of the control valve. This line may then be connected to the bleeder from the strainer on the upstream side of the control valve. These lines then are run to a drain leading to the slop tank. By blowing down each of these connections once each shift, both the strainer and the control valve can be kept clean.

Eccentric Reducer Is Easy to Lay Out

Here is a simple way to lay out an eccentric reducer. The directions are shown and this method will work for any size pipe within reasonable limits.

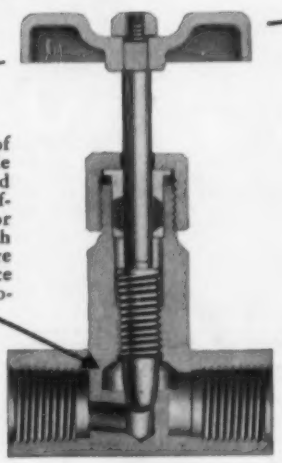
Be sure to allow the proper amount on the large pipe as shown in the sketch. The first step is to locate the various points and draw in the cut lines. Cut out E,B,A,G,C,D,P, and the remaining portion of the pipe that was allowed in step three. Then heat the pipe with a welding torch and hammer into shape.

(More How to Do It on page 179.)



MAXIMUM WORKING PRESSURE
10,000 PSI
for water, oil or gas

- Body and stem guide extra heavy bar stock fused into one piece.
- Valve stem 416 stainless steel.
- Packing special one-piece "Marpak" moulded ring.
- Bodies marked in accordance with MSS regulations.



ONE PIECE

The stem guides of conventional needle valves are screwed into bodies—this often causes leakage or blow-outs. Marsh Needle Valves are fused into one-piece by exclusive "Conoweld" process.

The Ultimate in Needle Valves

Here is one of the crowning achievements of Marsh research, design, and manufacturing skill. It is the first needle throttling and shutoff valve to combine *all* of the qualities called for today in this highly critical and ever broadening field.

It is a valve that has strength and safety to spare . . . rated for pressures up to 10,000 psi—equally efficient in the lower ranges. A product of Marsh instrument-making and valve manufacturing experience, it combines instrument-like precision with the ruggedness that distinguishes all Marsh valve specialties.

The illustrations tell the story of new thinking; new standards. Body and stem-guide are machined from extra-heavy carbon steel bar stock. Still greater strength and rigidity are achieved by fusing the stem-guide into the body. The complete fusion of guide and body is accomplished by the exclusive Marsh "Conoweld" process.

There are two big advantages to this one-piece construction: (1) It eliminates the danger of unscrewing the valve from the body when opening—a frequent cause of leakage, even dangerous blow-outs (2) It permits perfect line-up of threads and seat. As a result, Marsh valves are easier to operate even at high pressures.

The precision-machined stem is 416 stainless steel. Stem threads are fine pitch for extra strength and fine, controlled regulation. Notable advancements are special "Marpak" one-piece, non-binding longer-lasting packing; deep thread chambers, keeping inlet and outlet piping away from ports and contributing excellent flow characteristics. Entire packing nut and packing gland are electro-zinc plated, preventing corrosion and giving the valve a handsome, plated exterior. The rugged malleable handle is finished in heavy baked enamel.

The new needle valve line includes globe and angle patterns with double female connections in sizes ⅛", ¼", ⅜", ½", ¾" and 1". Also globe and angle valves with male inlet and female outlet in sizes ¼" and ½". *Complete stock carried at our Skokie, Illinois factory and also at our branch plant in Houston, Texas.*

Write today for catalog giving complete details.

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MARSH

"THE STANDARD OF ACCURACY"

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IT'S NEW!

Paracoil OIL-LEAK DETECTION SYSTEM

for STEAM TYPE FUEL OIL HEATERS

Type LP-20
Condensate
Inspection Tank

Continuously Monitors the Purity of Condensate leaving Steam-Type Fuel Oil Heaters

- Isolates all fuel oil entrained in the condensate stream
- Gives alarm to plant Personnel
- Protects the boiler by removing oil contamination from feed-water cycle
- Applicable to both low and high pressure steam plants
- Engineered to the special requirements of each installation

Write for further details

DAVIS ENGINEERING CORPORATION

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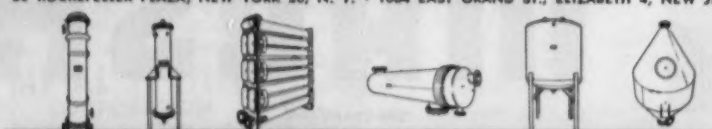


Since 1915 . . . Paracoil's skill to do comes of doing . . . Since 1915

How to Do It . . .

Make Temporary Pipe Rack From Welded Scrap Pipe

When necessary to rack up pipe for a few months prior to use, low cost temporary racks may be welded from scrap pipe.

Two cross members for the foot of the supporting legs are notched and welded together at 60 degree opposite angles. A length of pipe is notched at each end and welded in a vertical position to the intersection of the footing cross. A short length of pipe with inside diameter large enough to fit the size pipe racked is split and welded to the vertical member to form a saddle.

Several supporting legs are aligned and a length of pipe placed across the saddles to form a horizontal supporting joist. Two or three such joists are set up parallel to each other about eight feet apart to complete the rack.

Use Power Auger Assembly To Dig Anode Holes Quickly

A shop-designed trailer and boom assembly for a power auger has been used to good advantage in drilling holes for cathodic protection anodes.

The framework is mounted on an L frame attached to a small trailer. In operation, the power auger motor unit is mounted between the two uprights of the frame, holding the auger rigid. The auger may be raised and lowered by riding along the inside of the frame.

That Terrific Traffic!

An avalanche of steel, glass and rubber! But one hand can stop it. And a common source creates it.

It's the refractory brick which line the furnaces of industry.

Everything you buy or use owes its place in your home to refractories, which must meet demands of almost infinite variety and severity.

To make them, General Refractories employs the research of the world's largest and most modern refractories laboratory . . . brings materials from half way round the globe. And provides them to industry swiftly . . . dependably . . . economically from a multitude of strategically located plants and warehouses.

GENERAL REFRACTORIES CO. PHILADELPHIA 2

GENERAL REFRACTORIES

A COMPLETE REFRACTORIES' SERVICE

FOR THE PETROLEUM INDUSTRY . . .

LITECAST-50—A hydraulic setting light weight castable having a density of approximately 50 lbs. per cu. ft. Available in regular mix and pneumatic gun mix.

HIGH-STRENGTH BRIK-CAST—A hydraulic setting clay base castable having exceptionally high strength. Available in regular, pneumatic gun mix and trowel mix.

GREFCO CASTABLES are manufactured at 4 strategically located plants in Pennsylvania, Missouri, Texas, and California.

Have you tried **ALCOA**

It resists:

sulfur-bearing gases
carbon dioxide
cooling waters
refinery atmospheres
seacoast environments

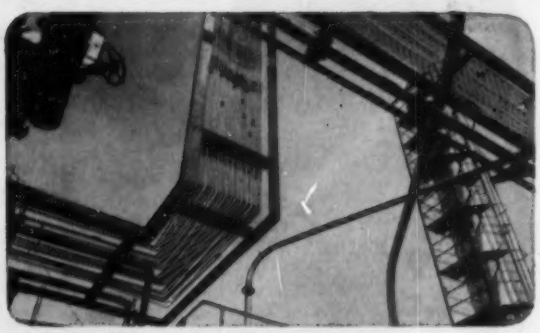
It costs less than other corrosion-resistant metals

It has successfully handled all of these commodities:

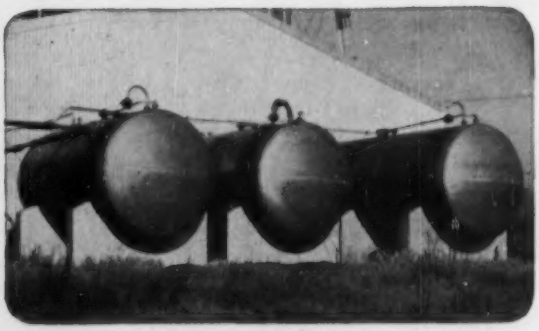
Acetaldehyde
Acetanilide
Acetic Acid
Acetic Anhydride
Acetone
Acrylic Acid, Glacial
Acrylonitrile
Aerosol Propellants
Alcohols—methyl, ethyl, propyl and higher
Ammonia Gas and Solutions
Ammonium Nitrate and Ammoniated Ammonium Nitrate
Amyl Mercaptan
Benzaldehyde and Benzyl Alcohol
Benzene
Butyric Acid and Anhydride
Carbon Dioxide Gas and Solutions
Creosote
Diethanolamine
Essential Oils, Edible Oils, Vegetable Oils
Explosives
Fats, all types
Fatty Acids—oleic, palmitic, stearic, etc.
Formalydehyde
Gases as Butane, Propane, etc.
Glycerine
Glycols—ethylene, propylene
Glycolamine Solutions
Hexane
Hydrogen Peroxide
Latex and Ammoniated Latex Solutions
Methyl Ethyl Ketone
Mineral Spirits
Monoethanolamine
Napthalene
Naphtha, Solvent
Naval Stores—rosins, turpentine
Nitric Acid (above 82%)
Nitroparaffins, crude and refined
Orthodichlorobenzene
Oxygen, Nitrogen and Liquid Air
Paraffin
Phenol
Resins, synthetic
Sulfur
Tar and Tar Products
Thinners, Paint
Toluene
Trichlorobenzene
Waxes—petroleum
Water—distilled, fresh, brackish, sea

It is light in weight . . . easily worked . . . strong

It resists corrosion . . . has excellent low-temperature properties



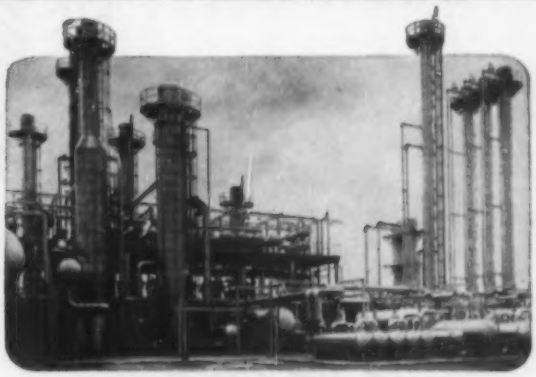
ALCOA ALUMINUM INSTRUMENT TUBING is enjoying wide use in the petroleum industry. ALCOA Utilitube® comes in lengths up to 1,000 feet and more . . . costs 40 per cent less than other corrosion-resistant metal tube.



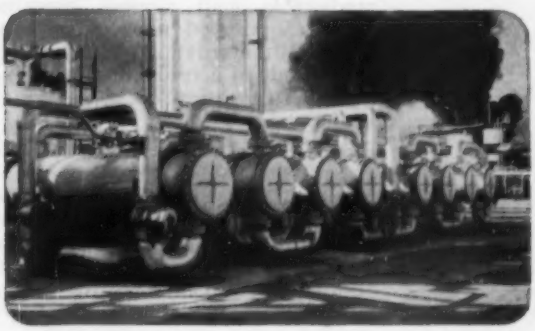
ALCOA STANDARD STORAGE TANKS give excellent service. Aluminum tank roofs have been in service more than 22 years in locations where steel failed in less than five years. Aluminum tank cars have been in use more than 25 years.

ALUMINUM in your refinery?

ALCOA ALUMINUM PIPE is light, easy to handle. It does not cause sludging of lubricating oil or gum formation in gasoline. Welding, threaded or other mechanical fittings can be used. Ideal for handrails, scaffolds, gates.



ALCOA ALUMINUM SHEET is used to weatherproof towers, heat exchangers and pipelines. It's the favorite lightweight metal for roofing and siding that withstands corrosive atmospheres with minimum maintenance.



ALCOA ALUMINUM HEAT EXCHANGER TUBES have been used for more than 20 years, handling sour gasoline stocks. Ideal for catalytic overhead condensers, compressor intercoolers and aftercoolers.

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Flexitallic Spiral-Wound Gaskets have made important contributions to almost every engineering development since 1912 — atomic energy, power plants, chemical processes, aircraft design. From this storehouse of experience, we provide the one right gasket for every job — an extra margin of safety, longer service life, and increased economy of operation.

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*Not all spiral-wound gaskets are Flexitallic. Look for *Flexitallic Blue* —it's our exclusive blue-dyed Canadian asbestos filler.

Who's Building . . .

Construction Boxscore Starts on Page 203

Sun Completes Biggest Houdriflows

William H. Davis and Raymond C. Lassiat,
Sun Oil Company

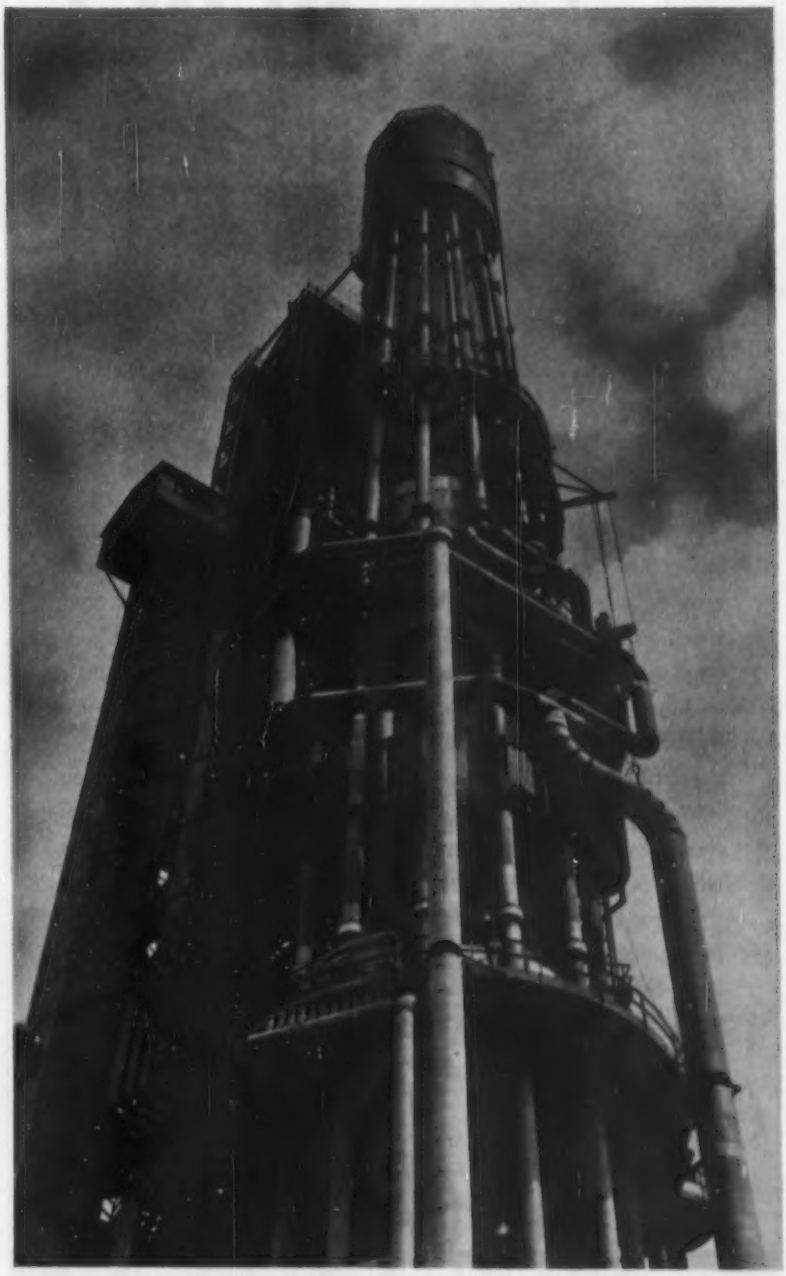
SUN OIL COMPANY recently completed new Houdriflow catalytic cracking units at its refineries in Toledo, Ohio, and Marcus Hook, Pa. Installation of the new equipment began early last year after the company, already facing maintenance problems with its crude-catalytic cracking fixed-bed units, decided to bring its cracking capacity more in line with its crude runs. At Marcus Hook, added flexibility also was needed to process high sulfur crudes.

The small area required by Houdriflow units (some 2800 sq. ft.) made possible their installation close to existing structures, without interfering with operation of the old units, allowing minimum work and shutdown time for the final tie-in.

Engineering was handled by Houdry Process Corporation, Sun Oil Company and Catalytic Construction Company. The latter, as prime contractor, handled most of the construction work, with the exception of revamping existing equipment, done by the refinery staff.

Both units were designed for an ultimate throughput of 28,000 barrels a day, comprising about 20,000 barrels of fresh distillate and 8000 barrels of recycle. The coke burning capacities are 16,000 pounds an hour, and the catalyst circulation is 700 to 800 tons an hour, insuring a conversion of about 70 percent of the fresh feed. This is the largest capacity ever built in a single Houdriflow unit.

The charge to the reactors comprises two streams: one from the tar separator, or atmospheric flash tower, introduced directly at the top of the



Twin units on stream at Toledo and Marcus Hook.

NO Interleakage Between Circuits HERE!

When it is necessary, because of the nature of the fluids being handled, to obviate interleakage between the shell and tube circuits of a heat exchanger, our double tube sheet construction is the answer. Since independent tube sheets are employed for each circuit, and a void separates them, interleakage through a tube — tube sheet joint is impossible. In the outside packed exchanger illustrated, the shell side parts — shell, baffles, and inboard tube sheets — are of copper silicon alloy, while the outboard tube sheets and channels are of steel. The bi-metallic construction is carried even to the tubes which are ⅝" O.D. steel, clad with 1/16" copper wall.

Heat exchangers of this type are discussed, among others, in Whitlock Bulletin 250. Write for your copy today — and use it for reference in selecting your heat transfer equipment. The Whitlock Manufacturing Company, 75 South Street, West Hartford 10, Connecticut. In Canada: Darling Brothers, Ltd., Montreal.

Whitlock

Designers and builders of bends, coils, condensers, coolers, heat exchangers, heaters, piping, pressure vessels, receivers, reboilers.

Who's Building...

reactor through two opposed vapor inlets; the other stream introduced as liquid recycle, pumped hot from the synthetic crude tower. At the Marcus Hook unit, vacuum gas oil will be admitted as liquid along with the recycle stock.

The liquid injection nozzles are of conventional design, providing atomization of the liquid with steam, and intimate contacting of the oil charge with a curtain of falling catalyst. The liquid was split into four streams, each feeding to a nozzle through a flow controller.

The regenerator comprises three burning zones, each with the temperature controlled by two banks of cooling coils above the middle of the center and lower zone.

The design of reactor and regenerator internals, such as oil distribution, oil disengaging, catalyst and air distribution, is in line with conventional Houdry practice. A centrifugal, back pressure steam turbine driven blower, rated at 55,000 CFM at 5 psig discharge pressure, furnishes air for catalyst regeneration. A conventional air heater supplies heat for starting up. Regenerated air is supplied at three levels and adjusted by remote control butterfly valves. (See Flow diagram on page 186.)

One design is the arrangement of 12 lift pipes around the reactor-regenerator vessel. The combination catalyst disengager-surge hopper is above the reactor and supported by the reactor-regenerator vessel through a steel skirt. The service platforms are attached directly to the vessel, making minimum steel structures necessary. A generous allowance was made in the seal leg between the surge hopper and the reactor. An 85-foot leg allows a reactor outlet pressure of 10 psi or more, and a pressure of 4 to 5 psi can be maintained at the suction of the gas compressors, making for economy in compressor capacity and operating cost.

Allowance was made in the overall design for the added flexibility of Houdresid processing, a new Houdry process.

On both units the regeneration flue gases, at about 900 F., are piped to a waste heat boiler. The flue gases pass through a bed of Oxycatalyst elements which oxidize carbon monoxide produced in the process of catalyst regeneration, as well as traces of oil vapors, increasing the temperature to about 1500 F. The heat is absorbed in the boiler-economizer system and some 50,000 pounds an hour of steam is produced—more than enough to drive the regeneration air blower. Oil burners in the boiler firebox give stand-by capacity for starting up. This steam production, along with steam produced by the cooling coils in the regenerator and by oil heat exchange, make the units self-sustaining in steam.

At the Marcus Hook unit, additional heat is recovered by carbon-monoxide combustion in the flue gas used in the gas lift, again by contact with the oxidation catalyst, and cooling by water coils operating in parallel with the regenerator forced-circulation cooling coils.

The former control room is used for the crude, vacuum and distillation sections. A new control room centralizes the catalyst section controls on a graphic panel. The catalyst level in the surge hopper is indicated by an instrument, developed by Sun Oil Company.

Additional Equipment at Toledo

At Toledo, little additional equipment was necessary. To accommodate the in-

CHARTING A COURSE FOR THE FUTURE

Like the rugged seafarers of an earlier century, modern industrial organizations are continually faced with the problems of charting a course which will ensure their future success.

And when the designated route requires the expansion or modernization of their processing facilities, these organizations must be certain that the construction firm selected for the job will be one with an outstanding record of past achievements.

Throughout the world, Procon has shown its ability to handle any process construction work efficiently and economically. With such a record, Procon has enabled its many clients to enjoy the benefits of rapid on-stream operations.

Discuss your next process construction job with a Procon engineer. You'll find him ready to assist you in planning your course for the future.

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creased oil rate, and to minimize the alterations of existing equipment, a quench tower was installed ahead of the existing synthetic crude towers. In this vessel vapor effluent from the reactor is cooled by contact with recirculated quench oil to about 600 F. Heat absorbed in the quench oil is recovered by heat exchange against flashed crude and boiler feed water. Remaining vapors are introduced at the base of the existing synthetic crude towers, and bottoms from the synthetic crude towers pumped back on top of the quench tower. A fuel oil cut is drawn from the bottom of the quench tower, a recycle cut from the bottom of the synthetic crude tower, a catalytic furnace oil as a side stream from the synthetic crude tower, and catalytic gasoline is taken overhead.

Some additional heat exchange was necessary. All auxiliary equipment was installed, ready to tie in, prior to completion of the Houdriflow unit and while the existing unit was operating. When construction was finished, the old unit was shut down for yearly inspection and cleaning and tie-in connections were completed. Ten days after the old unit was shut down, the new unit was on stream.

Additional Equipment at Marcus Hook

In addition to the quench tower and new heat exchange equipment at Marcus Hook it was necessary to replace a few tubular (including the reduced crude furnace) with alloy equipment to withstand expected corrosion connected with projected high sulfur processing.

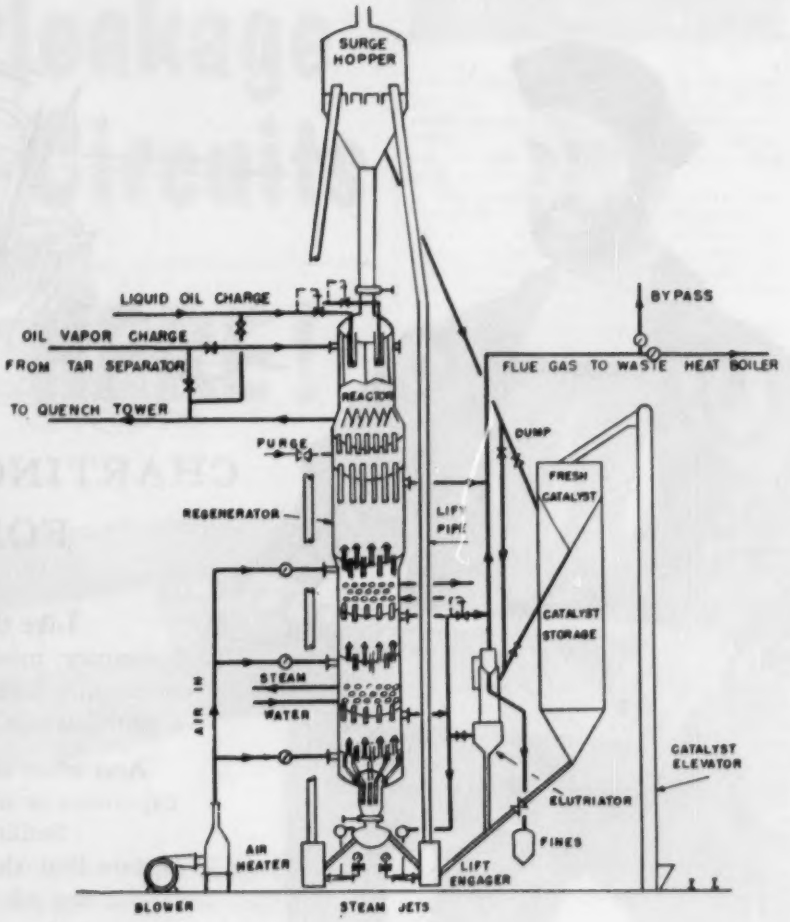
Facilities for crude desalting were added to the existing distillation plant to minimize fouling and corrosion, and a vacuum flashing section was built to reduce heavy sour crude oils.

Due to the large amount of alterations at Marcus Hook, start-up operations there were not as clean-cut as at Toledo. The first step was to go on stream, using an available furnace while the regular reduced crude furnace was revamped. When work on the reduced crude furnace was finished the unit was started on sweet crude. The vacuum tower was completed later and heavy crudes now are being charged.

Construction Work

The size of the main vessels precluded extensive shop fabrication, and the vessels were welded together in the field.

Complete sections were assembled on the ground from steel plates rolled to shape and pre-cut to size, stress relieved when necessary in a special furnace built on the site, then lifted and welded in their final position. To assemble the sections a guyed derrick was used.



New Sun Units Integrated—

Sun Oil Company's new 28,000-barrel-a-day catalytic-cracking units, now on stream at refineries in Toledo and Marcus Hook, feature a number of design innovations including a circular arrangement of 12 catalyst lift pipes around the reactor-regenerator vessel and integrated Oxycat waste heat exchangers.

Planning

Imperial Oil, Ltd., has completed engineering and awarded a contract for construction of a catalytic-polymerization unit and naphtha fractionator at its refinery in Ioco, B. C. Bechtel Corporation's Canadian affiliate, which recently completed Imperial projects at Sarnia, Ont., and Montreal, Queb. (see Completed), expects to finish the $2.4-million Ioco expansion by fall.

At Imperoyal, N. S., near Halifax, Imperial has another expansion due for completion this fall. The new $27.3-million facilities under construction there will provide another 41,600 barrels a day of refining capacity. Imperial has scheduled the re-built plant to go into operations in November.

As part of the same project, the Standard Oil Company (New Jersey) affiliate will spend some $500,000 to insure that water taken from Halifax Harbor will be returned free of contamination. Scheduled for completion by the end of the year, the new pump house and oil-separating facilities are being built for a daily capacity of 35 million gallons. Foundation Maritime, Ltd., of Halifax, holds the contract for anti-pollution work.

Construction of a 2000-barrel-a-day lubricating-oil plant at the Imperial refinery in Edmonton, Alba., was proceeding on schedule, with completion of the $13-million installation set for this month. The new Edmonton plant, like the processing units at Imperoyal, is being built by Canadian Kellogg Company.

Quebec Ammonia Company plans a 120-ton-a-day synthetic ammonia plant at Varennes, near Montreal. It will be the first such plant in the Montreal area.

B. F. Goodrich Chemical Company has awarded the contract for engineering and construction in connection with the expansion of its recently-acquired Hycar Synthetic-rubber facilities in Louisville, Ky. The Girdler Company will erect a new warehouse and additions to the plant's reactor building. Goodrich engineers will handle the design and procurement of process equipment.

El Dorado Refining Company plans to install a 2500-barrel-a-day catalytic-reforming unit at its refinery in El Dorado, Kansas. Plant personnel recently completed additions to the crude-distillation facilities, increasing thruput by 5000 barrels a day to reach a daily total capacity of 15,000 barrels.

Ente Nazional Idrocarburi has secured a five-year loan for $4 million to help purchase U. S. equipment and technical services for construction of its proposed $75-million synthetic-rubber and nitrogenous fertilizer plant at Ravenna. Manufacturers Trust Company and the

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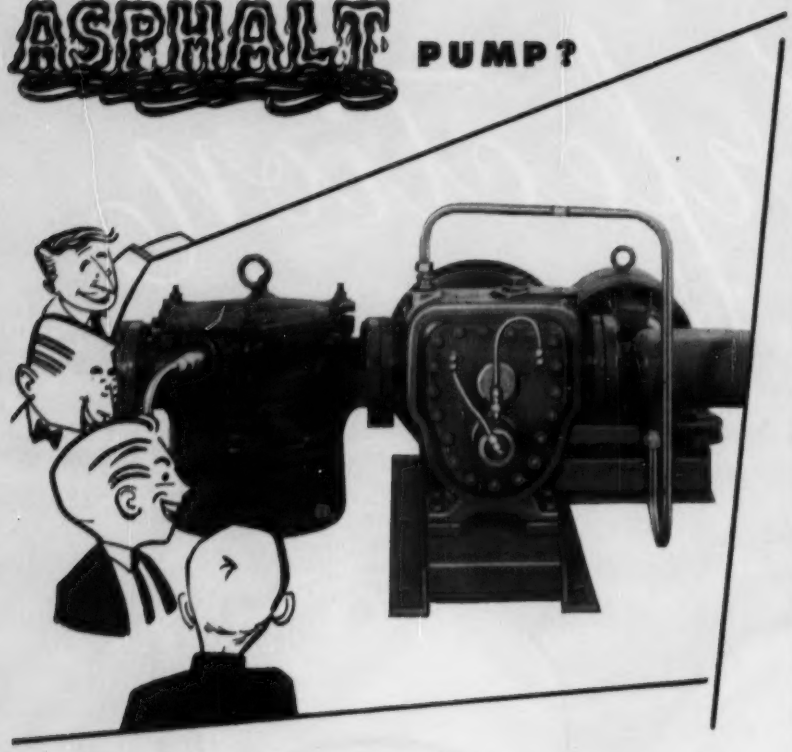
LOOKING FOR AN

ASPHALT PUMP?



Then you need a Kinney Model SD Rotating Plunger Pump. This simple, rugged pump has given continuous, economical service on hundreds of asphalt jobs, in some cases for over 25 years. It's designed to handle highly viscous materials — has no valves, blades, springs or vanes — and is lubricated by the liquid pumped. The Kinney SD Pump has unusually high volumetric efficiency and delivers hard-to-pump liquids with meter-like accuracy. Obtainable in capacities from 2 GPM to 3000 GPM — steam jacketed in most sizes. It's the *permanent* solution to many of your most difficult pumping problems.

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Please send Bulletin L51 describing the complete line of Kinney Liquid Pumps.

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Who's Building . . .

Bank of America joined in the loan to the Italian state agency. Engineering of the 30,000-ton-a-year rubber plant will be handled by Phillips Petroleum Company, who has agreed to assit with the copolymer facilities, and Union Carbide & Carbon Corporation, which will help with the butadiene units.

Western States Refining Company plans a $1,200,000 expansion and modernization program at its refinery in North Salt Lake, Utah, calling for installation of a catalytic reformer and asphalt plant.

American Gilsonite Company plans a $10-million project for making gasoline and metallurgical coke from gilsonite, a solid hydrocarbon mined at Bonanza, Utah. The plant, to be built in Western Colorado, will process between 600 and 700 tons of the mineral a day. Equipment will include a fractionator, reformer and delayed coker. Construction will begin this fall and be completed late next year. The company is owned jointly by Standard Oil Company of California and Barber Oil Corporation.

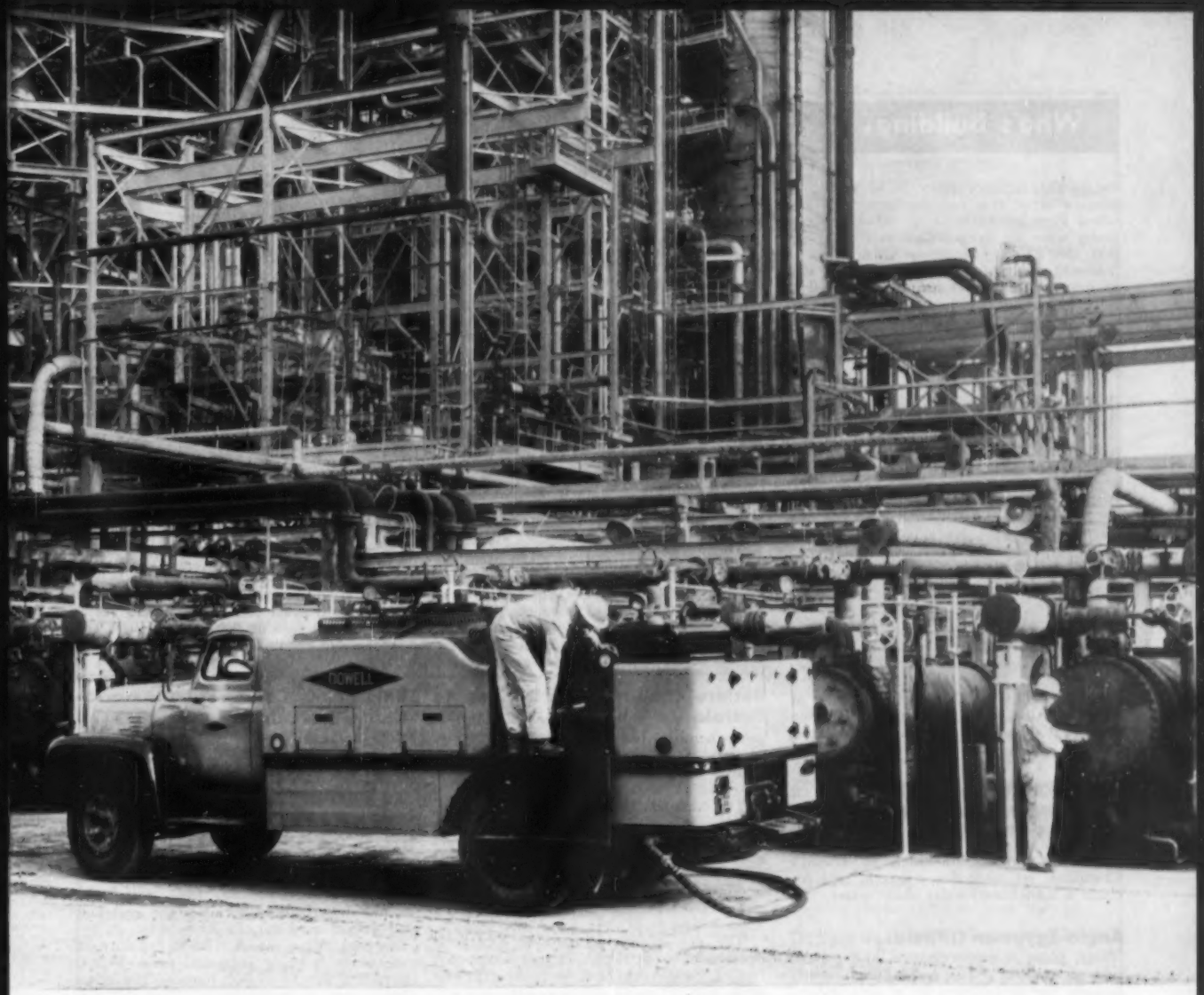
Commerce Oil Refining Corporation proposes to build a new 30,000-barrel-a-day refinery near Portsmouth, R. I. No final decision has been made to build the plant, but should the company undertake the project it is expected to put up a refinery costing $30 million. The plant, being designed by The Lummus Company, would include five catalytic processes. The would be cracking, reforming, alkylation, polymerization and hydrogen treating. The combination atmospheric and vacuum crude unit would be sized to charge 40,000 barrels a day. The catalytic crackers would be rated to take a total reactor charge of 25,000 barrels.

Crystal Refining Company of Carson City (Mich.), Inc., will modernize the company's 6200-barrel-a-day topping unit. Plans for construction follow the company's recent acquisition by Harry Litwin, of Wichita, Kansas, and Edward Fleischman, Detroit, Mich. Litwin is vice president and director of Central Refining Company in Garden City, Kansas, while Fleischman is president of Lakeside Refining Company at Kalamazoo, Mich., and an officer in Petroleum Specialties, Inc., a Flat Rock, Mich., company.

Phillips Petroleum Company will construct a natural gas liquids extraction plant near Andrews, Texas. The plant, which will have an initial capacity of 33 Mmcf. a day, will be the second natural-gasoline plant built by Phillips in Andrews County and will bring to 11 the number of these plants operated by Phillips in West Texas and southeastern New Mexico.

Commercial Importadora, S. A., Mexican distributor for Quaker State Oil Refining Corporation, will build a 2000-barrel-a-day lube-oil blending plant in Mexico. Another blending and compounding plant will be built by Compania Commercial Vacuum, S. A., Socony Mobil Oil Company marketer. These are the first

For more data on advertised products, use Readers' Service Cards, last page.



While the cat cracker remained in full operation, DOWELL cleaned six slurry exchangers chemically . . .

UPPING THROUGHPUT 900 BPD

No cat cracker operator wants to see his throughput go down. Neither did this one. Nor could he afford to wait for the annual shutdown to give six slurry exchangers the cleaning they obviously needed *fast*. His solution? Call Dowell to remove the scale deposits with chemicals.

Dowell engineers devised a procedure for cleaning the exchangers *with the cat cracker in full production*. The exchangers were cleaned by Dowell one at a time, while the remaining five units carried the load.

As a result of chemical cleaning, the operator reported a jump in throughput of *900 barrels per day* . . . plus an average increase of 26° in the heat co-efficient of the exchangers.

Dowell Service is designed to restore *your* equipment to top efficiency—and do it *fast*, with the very minimum of costly downtime. Experienced Dowell engineers do the job for you. They bring all the necessary chemicals, pumps and control equipment right into your plant. Solvents are introduced through regular connections, holding dismantling to a minimum.

For full information on a program of Dowell chemical cleaning for *your* plant, call your nearest Dowell office. Or write Dowell Incorporated, Tulsa 1, Oklahoma, Dept. G-31.

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Who's Building . . .

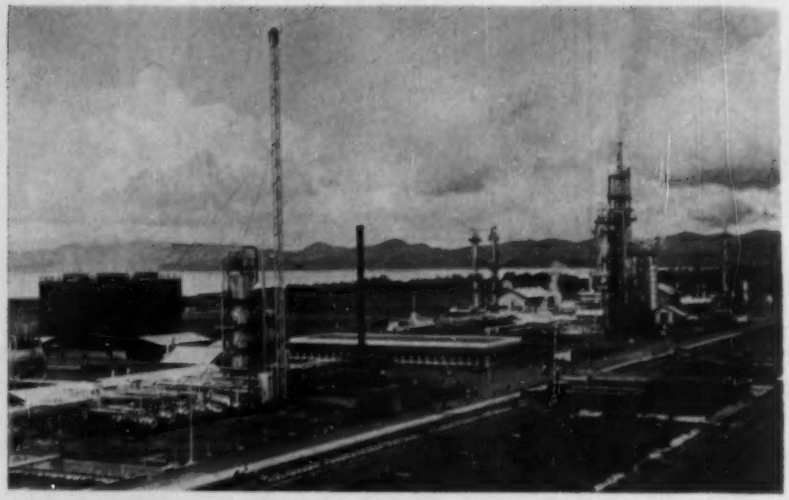
companies authorized to build plants in Mexico since the ban on imports raised when Petroleo Mexicanos' Salamanca refinery went on stream. Due to cost $700,000 the 570-barrel-a-day Commercial Vacuum plant in the Federal District will go into operation next spring. Scheduled to start operations in September, the Commercial Importadora plant will produce only automotive lubricants at first, but plans call for an output of industrial lubes by the end of the year.

Richfield Oil Corporation plans to add a 17,000-barrel-a-day catalytic-reforming unit to its refining facilities at Watson, Calif. To be the world's largest unit using a Sinclair-Baker catalyst and the West Coast's first, the new reformer is scheduled for completion in mid-1956. The cost was not disclosed on the project to be started in August.

British American Oil Company will add three more catalytic-reforming units at its Canadian refineries. The new units will be installed at plants in Clarkson, Ont.; Moose Jaw, Sask., and Edmonton, Alba. The company recently added a 2000-barrel-a-day Atlantic Catformer at Calgary, Alba., and is nearing completion on a 13,000-barrel-a-day unit at Montreal, Queb.

Union Oil Company has selected Stearns-Rogers Manufacturing Company as engineering contractor for the shale oil demonstration plant to be built near Rifle, Colo. The project, included in Union's $5-million set aside for research, will include a 1000-barrel-a-day shale retort.

Anglo-Egyptian Oilfields, a Shell affiliate, plans a modernization and expansion of its Suez refinery. The project will include the installation of a catalytic-reforming unit.



Philippines' First Refinery On Stream—

Caltex (Philippines), Inc., now has on stream the Philippine Islands' first refinery, a 26,000-barrel-a-day plant at Bauan, Batangas. The new refinery, using imported crudes, runs an average of 13,000 barrels a day. Shown are the crude-distillation unit, power plant, Born Upflow heater with stack in the center of the picture, and other installations such as the machine shop. The refinery was built by Foster Wheeler Corporation, which also handled some engineering, along with Arthur G. McKee Company and Bechtel Corporation.

Societe Chimique des Derives du Petrole will build Belgium's first major petrochemical plant. Scheduled for completion at Antwerp next year, the new facility will include units to produce ethylene oxide and ethylene glycol.

The company, known as Petrochim, will be financed in its project by 11 major Belgian corporation, which have $8 million available for the project, including $2 million loaned by the Belgian government. Leading shareholders include Societe Belge d'Azote, Carbochimique, Petrofina and Sofina.

The new plant will employ a process developed by Scientific Design Company, Inc., a New York firm, to make ethylene oxide without using chlorine. Ethylene will be united directly to oxygen over a catalyst.

Consumers Cooperative Association will install three new units at its Coffeyville, Kansas, refinery. The new units will be a 5000-barrel-a-day Platformer, a 3000-barrel-a-day Unifiner and a 7000-barrel-a-day delayed coker with hydraulic-decoking equipment. Contracts for construction will be let this summer, with the units scheduled to go into operation early next summer.

Leonard Refineries, Inc., will build a 3600-barrel-a-day Ultraforming unit and a 4200-barrel-a-day Hydrofiner at its refinery in Alma, Mich. Crude capacity at the plant is being increased from 10,500 barrels a day to 14,000 barrels. The company also is installing a sulfur-recovery unit which will convert hydrogen sulfide to about 10 tons a day of elemental sulfur. The new catalytic reformer will be licensed by Standard Oil Company (Indiana), and the hydrogen-treating unit will be licensed by Esso Research & Engineering Company. Leonard is the first company not affiliated with Jersey Standard to license a Hydrofiner.

Phillips Petroleum Company will erect a new chemical research laboratory near its Bartlesville, Okla., headquarters. The multi-million installation will be located on a site where Phillips now has several experimental and pilot-plant units.

Utah Oil Refining Company has awarded the contract for construction of a $3-million Ultraformer at its refinery in Salt Lake City. The work will be done by The Fluor Corporation, Ltd. The builder was to begin breaking ground immediately.

The Texas Company has awarded a contract for construction of its projected 4800-barrel-a-day Unifiner-Platformer unit at Casper, Wyo. The Fluor Corporation, Ltd., was selected to handle design, engineering and construction.

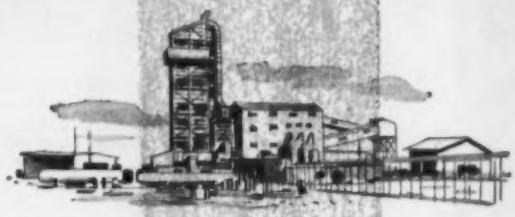
Engineering will get under way immediately, with the new unit scheduled for

Lima Construction on Schedule—

Construction is progressing on schedule at the Lima, Ohio, site of the new facilities for the Petrochemical department of The Standard Oil Company (Ohio). The first unit, a 300-ton-a-day anhydrous-ammonia plant, will be completed in September. All major pieces of equipment are set and pipe work is filling in on time. The next unit, scheduled for completion in November, is a nitric-acid unit with a daily capacity of 180 tons. Field construction is underway with most of the equipment at the site. The urea unit, the last in the field, will be in operation early next year. Blending, storage and shipping facilities will be completed along with the producing unit.

PETRO-CHEMICAL PLANT in Texas to produce ethylene from natural gas by the owner's process.

GENERATING PLANT, one of three of 66,000 KW each, installed for electric utility company in Southwest.



ORGANIC CHEMICAL PLANT to produce insecticides—DDT and BHC—located in the State of Alabama.

DIVERSIFICATION

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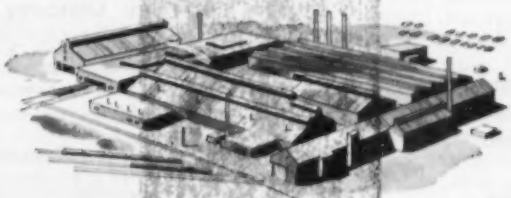
PAPER MILL in the South's pine belt, increasing its capacity by nearly 500 tons of newsprint daily.

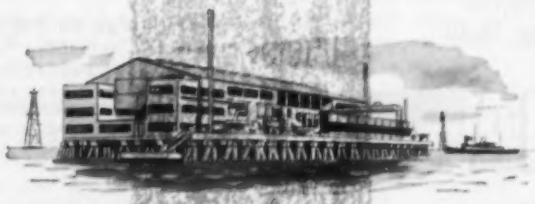
More than forty years of diversified experience in engineering and heavy construction in projects ranging from $50,000 to $125,000,000 in size... has put a razor-sharp edge on the Brown & Root estimating pencil.

This same sharp pencil can do the figuring for you with the same assurance known to a long list of satisfied Brown & Root clients... a list that reads like the Who's Who in Industry.

Behind each of our successful completions are arrayed the vital Brown & Root services developed by this long diversified experience... plant location data, economic surveys, design, engineering, home office supervision, cost accounting, procuring and expediting... all the cogs necessary to produce an economical, efficient facility for you. If your plans call for new construction or expansion, call Brown & Root. Plant planning experts will be put at your disposal. No obligation, of course.



STEEL MILL facilities expanded through contract with Brown & Root in excess of $70,000,000.



PRESSURE MAINTENANCE plant for Venezuelan gas reservoir built in 62 ft. of water with 50,000 h.p.

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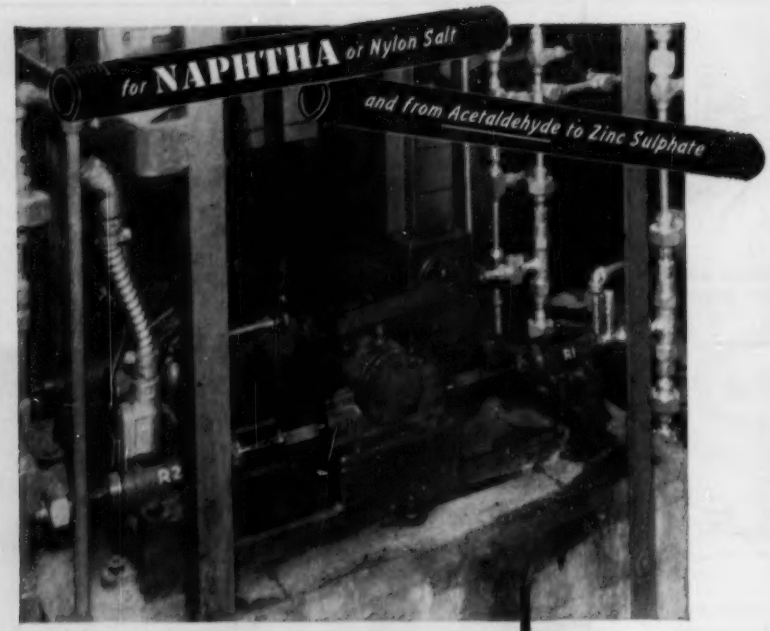

HILLS-McCANNA "U" Type metering / proportioning PUMPS

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Built to serve dependably in an industry that is *on the move*, the Hills-McCanna "U" Pump is daily finding new services to add to a diverse group of hundreds of different types of metering and proportioning jobs. But assurance of trouble-free performance through a wide range of problem fluids is only one of several versatile features offered by the "U" Pump.

One, two, three and four feed assemblies, mounted on a common base, are available in a range of capacities from 0.10 to 24.0 gph per feed. Operating pressures are from 125 psi to 5000 psi. Variable speed drive or a choice of 30, 40, 50 and 70 strokes per minute (with stroke length adjustment from 0 to maximum) provide efficient *controlled* pumping . . . reliability and accuracy that has made the "U" Pump the *preferred* pump for research, pilot plant and production uses.

Write for Bulletin UP-54, outlining "U" Pump service . . . recommendations for over 325 applications. And ask about other Hills-McCanna metering and proportioning pumps. HILLS-McCANNA CO., 2411 W. Nelson St., Chicago 18, Ill.

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Who's Building . . .

completion early next spring. Cost of the project has not been disclosed.

The combination unit will be used to process heavy straight-run plus cracked naphthas at the Casper plant. The refinery has a rated daily crude capacity of 17,000 barrels.

Ammonia Chemical Corporation of California will construct a $3,250,000 anhydrous-ammonia plant near Merced, Calif. The plant will process natural gas from nearby fields. The company will build an entire community for plant employes and their families.

Fertiza Limitada, recently organized by Peruvian and Italian interests, will build an ammonia- and nitrogenous fertilizer plant in Peru. Italy's Montecatini Company will direct construction of the petrochemical facility, expected to be in operation sometime next year.

The British Petroleum Company, Ltd., is considering a plant to convert petroleum products to gas at its Kent refinery. The company's initial installation is expected to convert some 50,000 tons of products a year to gas. It will have a daily output of 15 Mmcf. of gas and be arranged for expansion to 40 or 45 Mmcf. with an annual consumption of petroleum up to 150,000 tons a year.

Consolidated Chemical Industries, Inc., will build a $2-million contact sulphuric-acid plant at Le Moyne, Ala. Construction, scheduled to start immediately, will be completed by mid-1956. The company is nearing completion on a new spent sulphuric-acid regeneration unit at its Houston plant. The new facility will be similar to a unit put in operation at Baytown, Texas, in May.

Phillips Petroleum Company will build a 16,000-barrel-a-day catalytic reforming unit at its refinery in Kansas City, Kan. A contract to install the unit was awarded to Procon, Inc. Completion is scheduled for next spring.

Northwestern Refining Company, which recently completed a gas-concentration unit and new polymerization facilities at its refinery in St. Paul, Minn., plans to install a new crude unit, increasing the plant's capacity to 30,000 barrels a day. Other new process equipment, all due for completion in May 1956, will include a 6000-barrel-a-day catalytic reformer.

Cie. Financiere Belge de Petroles, S. A., is negotiating to build a 30,000-barrel-a-day refinery in Portugal. The company has sent government officials plans for the refinery to be erected near Luanda. Portugal has no production, but Petrofina is exploring the area around Benfica, near Luanda.

Big West Oil Company will install a $500,000 catalytic reforming unit at its refinery in Kevin, Mont. Scheduled for completion in October, the new unit will be built for a daily capacity of 1000

BRIDGEPORT BRASS COMPANY
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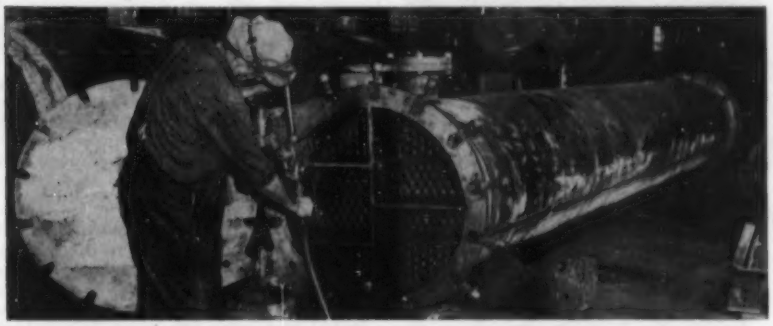
COPPER ALLOY BULLETIN

Bridgeport Brass Co. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



By combining two metals, Bridgeport Duplex Tubes successfully combat double-source corrosion in this heat exchanger.

Bridgeport Duplex Tubes Resist Dual Corrosion

Preventing tube corrosion, when inside and outside media are different, is a problem of prime importance to industries where heat exchange, condensation and cooling are necessary operations.

Bridgeport's advanced research and manufacturing processes have proved the answer to this dual-source corrosion... Duplex Tubes. These are dual-walled tubes made of the two metals which most successfully resist corrosion from both internal and external sources.

Combining copper and copper-alloys with ferrous and other nonferrous metals permits Duplex Tubes to be tailored to the individual application. The results are:

1. Long-term savings in reduced frequency of retubing.
2. Longer equipment life.
3. Less frequent equipment shutdowns.
4. Improved heat transfer properties.
5. Reduction of undesirable or dangerous product intermixing.

Wide Range of Applications

Proof of the success of Bridgeport Duplex Tubes in overcoming the problem of dual-source corrosion is the wide acceptance they have found in greatly diversified applications. Oil refineries, coke by-product plants, synthetic rubber plants, and many other specialized industries have found Bridgeport Duplex Tubes the answer to their dual-corrosion problems.

In the oil and natural gas industries, several varieties of Duplex Tubes have given improved performance over single-walled tubes. Examples are Duplex Tubes with steel outside to resist various corrosive petroleum vapors and copper alloy inside toward the fresh water; steel outside against the oil and Admiralty, Aluminum Brass or Cupro-Nickel inside toward circulating salt water. Others are alloy steel with copper alloys, aluminum with copper or brass, either inside or outside.

In the coke by-product and synthetic rubber industries where ammonia refrigeration plays a vital part, Duplex Tubes have been supplied composed of copper to water side, where it gives superior service, and steel to the ammonia side, to resist corrosion from that source. Were either metal to be used alone in a single-walled tube, frequent tube replacement would be necessary.

In chemical plants producing colorless formaldehyde, Duplex Tubes have been supplied having Admiralty outside for brackish water and aluminum inside to prevent product contamination. Other combinations for different processes also have proved superior.

In boilers and steam generators, Duplex Tubes with copper exteriors and steel interiors are used successfully. Hot gases pass through the steel and water surrounds the copper. In addition to longer service life from reduced corrosion, higher efficiency is made possible because copper-steel Duplex Tubes have better heat transfer qualities than ordinary steel tubes with the same wall thickness.

Duplex Tube Specifications

For condenser and heat exchanger applications, Duplex Tubes naturally conform to condenser tube specifications for size and composition. Generally supplied in straight lengths up to 30 feet, outside diameters range from one-half inch to three inches, and total wall thicknesses from .049" to $\frac{3}{8}$".

On thinner gauges, wall thicknesses of these tubes generally are divided equally between the two metals. On thicker gauges, the copper-base alloy or stainless steel component may range in thickness from 1/3 to 1/5 of the total. End-annealed tubes also are supplied.

Temperature Effects

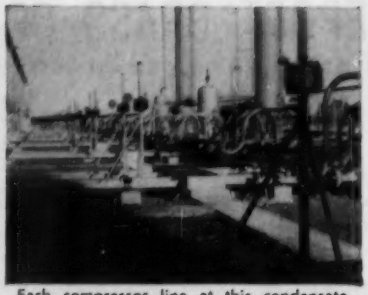
Questions occasionally arise in regard to the effects of extreme temperatures on Duplex Tubes because of their bimetal nature. Service experience has proved that Duplex Tubes are satisfactory under such conditions.

Tubes comprising materials with widely different coefficients of thermal expansion, such as copper-base alloys and steel are giving very satisfactory service in condensers, coolers and heat exchangers, where temperature of the tube ranges from 0°C to 100°C and even higher. Of course, tube temperature often does not reach that of the surrounding chemicals.

To assist condenser tube users in solving their corrosion problems, Bridgeport's Research Laboratory and Technical Service have compiled a wide background of experience and knowledge. The benefits of this background are available to you by calling your local Bridgeport Sales Office. Helpful information on Condenser Tube alloys, Duplex Tubes, corrosion of all types and other subjects are contained in the Bridgeport Condenser Tube Handbook. A copy of this useful 156-page book will be sent to you on request. (3330)

For more data on advertised products, use Readers' Service Cards, last page.

BS&B Safety Head used as a final relief device on a high pressure well-head. Platform and stair are BS&B Safwalk.



Each compressor line at this condensate recovery—pressure maintenance plant is BS&B Safety Head equipped.

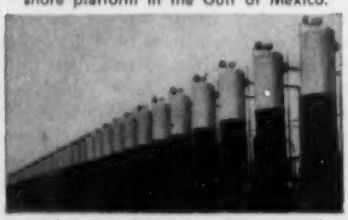
BS&B Safety Heads... Sentinels of the Oilfields!

Wherever you travel in the oil industry today, you are likely to see BS&B Safety Heads performing sentinel duty over millions of dollars worth of property and equipment and countless human lives! You'll find them on oil and gas separators, emulsion treaters, gas scrubbers and heat exchanger shells... on storage tanks, refinery pressure vessels, in gas compressor stations and along the pipelines. They are there for one purpose only—to provide *safe, instantaneous relief* from overpressure, should it occur in the system!

If you'd like a catalog or more information about BS&B Safety Heads, contact your nearest BS&B Representative...or write to us direct.

Each of these four gas scrubbers at a southern natural gasoline plant is protected by a BS&B Safety Head.

BS&B Safety Head on high pressure gas scrubber, as seen on a typical offshore platform in the Gulf of Mexico.



In this central separator battery, each vessel has a BS&B Safety Head for protection from overpressure.

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For Better Regulation of Pressures, Temperatures Liquid Levels or Flow, Equip Your Process With BS&B AUTOMATIC CONTROLS!

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Who's Building...

barrels. License agreements and construction contracts went to Universal Oil Products Company and its subsidiary, Procon, Inc.

Allied Chemical and Dye Corporation has awarded a contract for design and erection of a combination hydrogen and carbon-monoxide plant at the company's chemical works in Moundsville, Va. The contract went to The Girdler Company, and L'Air Liquide Society will supply a low-temperature fractionation unit for separating the two gases. The carbon monoxide and hydrogen will be employed in organic synthesis at the Moundsville plant. The new facility is scheduled to go into operation early next year.

The Atlantic Refining Company will build a plant in Louisiana to dry and recover hydrocarbons from natural gas. The new facility, to be erected by Jefferson Lake Sulphur Company, which also has agreed to operate the plant, will process some 40 Mmcf. of gas a day. The two companies will share the gasoline and other products.

Hedon Chemicals, Ltd., recently organized in England, will build a $2.5-million vinyl acetate plant at Greater Hull, in Yorkshire. The new company is owned jointly by Shawinigan Chemicals, Ltd., and Distillers Company, Ltd.

Petroleos Mexicanos plans to spend $64 million this year in improvements and expansion of its refineries at Azcapotzalco, Reynosa and Minatitlan. Premex's goal is to increase its products capacity 14 percent, boosting output from 272,500 barrels a day to 315,000 barrels.

Bankline Oil Company plans for modernizing the company's Bakersfield, Calif., refinery call for the installation of a coking plant and catalytic reformer together with the conversion of an existing hydrofluoric-acid alkylation unit into a sulfuric-alkylation unit.

The Standard Oil Company (Ohio) is considering a new $2 or $3 million research center in Cleveland. Construction of the new facility, in one of the suburbs, would replace existing facilities at Sohio's physical and chemical testing laboratory in Cleveland.

Under Construction

Shell Oil Company is adding a 16,000-barrel-a-day catalytic-reforming unit at its refinery in Houston. The new unit, designed by Universal Oil Products Company, will manufacture high-octane gasolines from naphthas. Also being installed at the Houston plant is a hydrodesulfurization unit of the same capacity, The contractor, Procon, Inc., expects to complete the reformer early next year.

Anderson-Prichard Oil Company has awarded the contract for construction of a $750,000 catalytic-reforming unit at its refinery in Arkansas City, Kansas. The

WESTERN UNION

FX-1201

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NL=Night Letter
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W. P. MARSHALL, PRESIDENT

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NEW REFINERY CATALOG CONTAINS 20 PAGES OF CATALOG DATA ON UNITED STATES RUBBER COMPANY PRODUCTS FOR REFINING AND PETROCHEMICAL INDUSTRIES. BELIEVE THE INFORMATION YOU WANT ON U.S. HOSE, EXPANSION JOINTS, PINCH VALVES, PACKINGS, PLASTIC PIPE, FITTINGS AND VALVES WILL BE FOUND PAGES 853 THROUGH 872 OF 1955 REFINERY CATALOG. NOTE PARTICULARLY THE PACKING RECOMMENDATIONS CHART ON PAGE 864.

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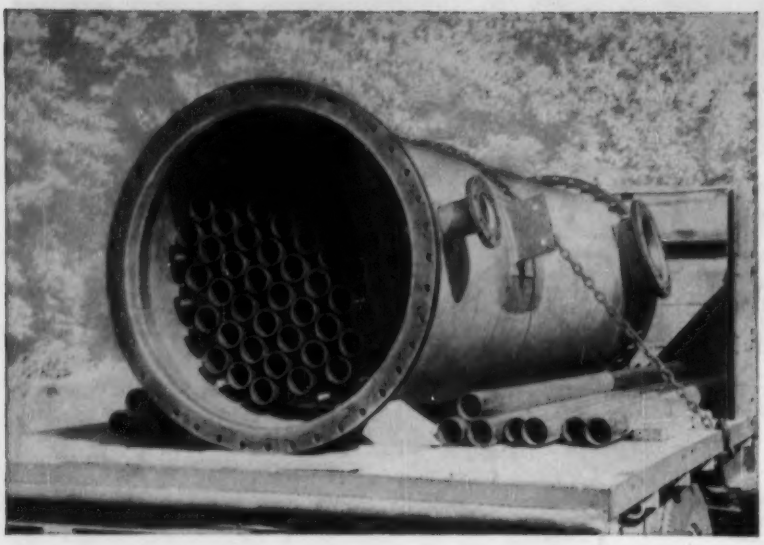
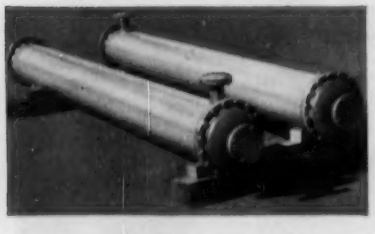
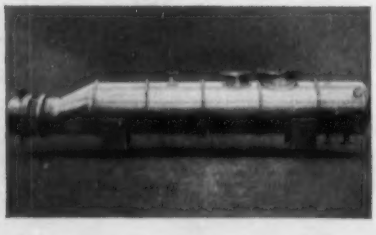


Special heat exchanger materials are well known at Downingtown!

Enamel-Lined Tubes. This stainless steel heat exchanger, with enamel-lined tubes, solved a serious set of problems which included high temperatures . . . heavy corrosion . . . intermittent operation . . . and a tight budget. It now operates at 150% of design capacity, at a temperature of 1200° F.—and the owner reports trouble-free service from his Downingtown unit. Dimensions: 28″ diameter x 10′ 0″ long. Stainless steel shell. Tubes: 3½″ O.D., lined with high temperature enamel.



Ampco 8—Downingtown engineered these two fixed tube sheet benzene condensers for export. Process conditions required copper alloy tube sheets, yet the customer did not want a gasketed joint between tube sheets and shell flanges. So we welded the Ampco 8 tube sheets directly to the steel shells, thus saving the cost of alloy shells. Dimensions: 14″ diameter x 12′0″ long. Eighty copper tubes, 1″ O.D. x 14 gauge. Ampco 8 tube sheets ⅞″ thick. Ampco 8 heads ⅝″ thick. Design pressure is 75 psi on shell and tube sides.



Solid Nickel—This solid nickel reboiler for vacuum service—one of eight identical units fabricated for one customer—was engineered by Downingtown to use a minimum amount of scarce and expensive materials. The double tube sheet construction required special assembly techniques. Notice the large nozzles, which were installed with a minimum of distortion by using proper care and skill during welding. Made of ¼″ solid nickel. Dimensions: 34″ diameter x 17′ 0″ long. Has 292 nickel U-tubes, 1″ O.D. x 16 B.W.G.

We furnish complete thermal and mechanical designs, or fabricate to your plans. Send now for additional information.

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Who's Building . . .

unit, a Platformer licensed by Universal Oil Products Company, will be erected by Southwestern Engineering Company. The 5000-barrel-a-day facility is scheduled for completion by late October.

Consumers Cooperative Association will build a $250,000 catalytic-reforming unit at its refinery in Scottsbluff, Neb. The project is scheduled for completion within six months. The refinery has a daily capacity for 2200 barrels.

Tide Water Associated Oil Company has started clearing the site for its new 130,000-barrel-a-day refinery to be built near Delaware City, Del. Grading and leveling is being carried out by George M. Brewster, sub-contractor for C. F. Braun & Company, the refinery's engineering contractor. When the 450-acre site is ready, main refinery units, now being fabricated, will be erected in a 1000-yard wire strip, extending for about a mile.

Gulf Oil Corporation has let contracts for construction of two new units for super-refining home-heating oil at its Port Arthur, Texas, refinery. Contractor for the units, each to have a 20,000-barrel-a-day capacity, is The M. W. Kellogg Company. No cost estimates were available. The process, a Gulf development designed for improving heating oil quality, is called Gulfining. Charge stock will be furnace oil made either from West Texas crude or produced by catalytic cracking.

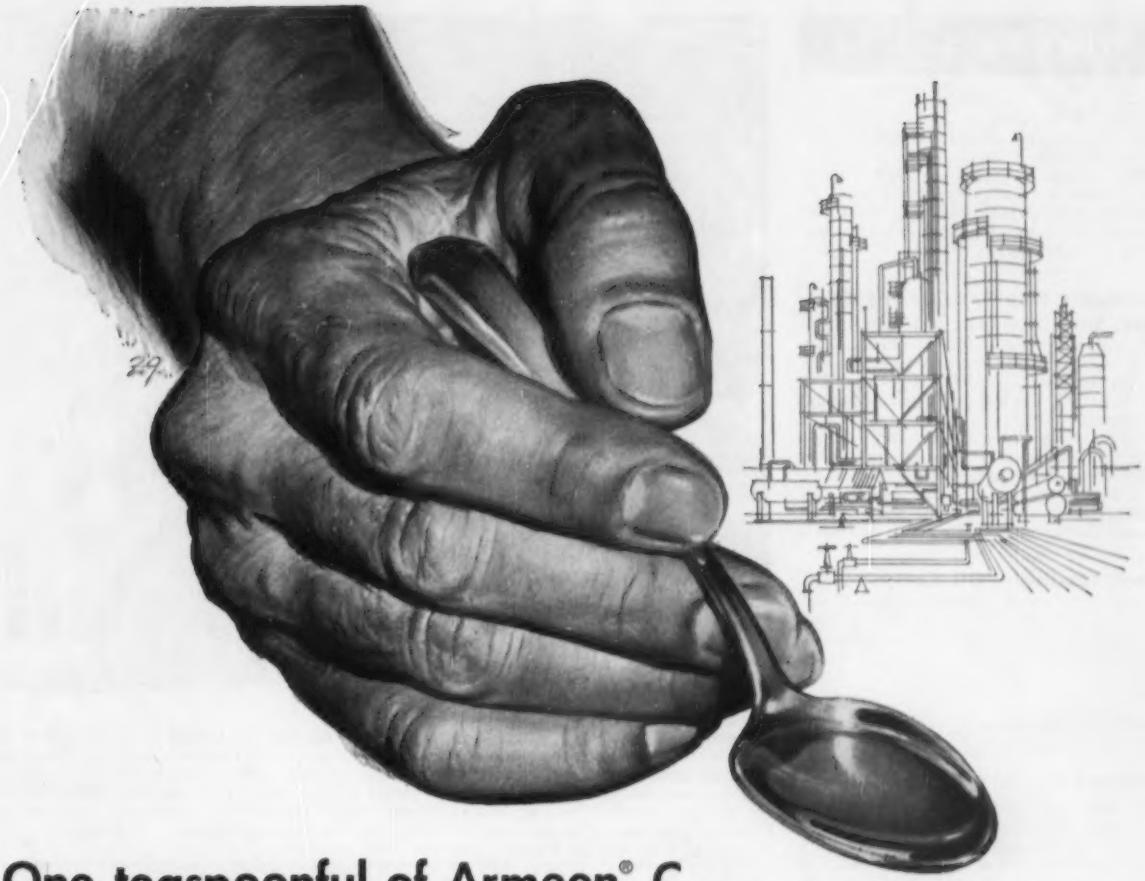
The Dow Chemical Company has scheduled its new synthetic-glycerine plant at Velasco, Texas, to be in production late this summer. The plant, being built for an annual rated capacity of 36 million pounds, fits the company's program of products derived from LP gas and brine. Construction started about a year ago.

American Oil Company has preliminary surveying under way on its new 35,000-barrel-a-day refinery near Yorktown, Va., with construction due to begin within the next few weeks. The plant, to be Virginia's first refinery, is scheduled for completion by late 1956. The M. W. Kellogg Company will build the major processing units for the production of LPG, motor gasoline, middle distillates and fuel oil.

Leonard Refineries, Inc., is having a 3500-barrel-a-day Ultraformer and a 5200-barrel-a-day Hydrofiner installed at its refinery in Alma, Mich. The company will enter the petrochemical field, utilizing excess hydrogen produced by the Ultraformer.

The Texas Company is erecting three new buildings as the first phase of an expansion of its research and testing facilities. The current program, to be completed next spring, calls for construction of two new buildings at the company's largest research center in Beacon, N. Y., and one at its largest refinery in Port Arthur, Texas.

At Beacon, Texaco is building a four-story analytical and testing building housing 51 offices and laboratories, together with a three-story addition to the administration building which will double that structure's office space. The new analytical



One teaspoonful of Armeen® C per 2,200 gallons of gasoline stopped corrosion—increased throughput 20%!

Here's dramatic proof of the efficiency and economy of Armour cationic amines and their salts: A West Coast refinery put Armeen C to work two years ago. Almost immediately, corrosion in casinghead condensers decreased 97%. Throughput increased 20%. The condensers—normally replaced every eighteen months—now have an estimated life of ten years. And only one teaspoonful of Armeen C to 2,200 gallons of gasoline did the job.

All Armour cationic fatty acid derivatives are effective at extremely low concentrations because they are essentially 100% active. And there is no costly variation in the results they give—Armour cationics are made to exact specifications for uniform, economical processing.

Armour cationics are solving a wide variety of cost and operating problems throughout the petroleum industry. If yours is a corrosion problem we recommend Armeen C and other Armour derivatives such as the Arquads® and Duomeen® TDO. If your problem is other than corrosion, our petroleum research group will be glad to assist you in solving it. Simply write us on your letterhead. Send the coupon for test samples of Armeen C and Duomeen TDO and further information on the complete Armour line of cationics for the petroleum industry.

Mail this coupon today

Please send me:

Samples: ☐ Free sample of Armeen C
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Information: ☐ Technical Bulletin G-3; Combat Corrosion
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For more data on advertised products, use Readers' Service Cards, last page.

and testing building at Port Arthur will give the company another 31 laboratories for use in quality control.

The control program at Port Arthur comes under the administration of Texaco's Refining department. The Beacon structures are additions to the company's Research & Technical department.

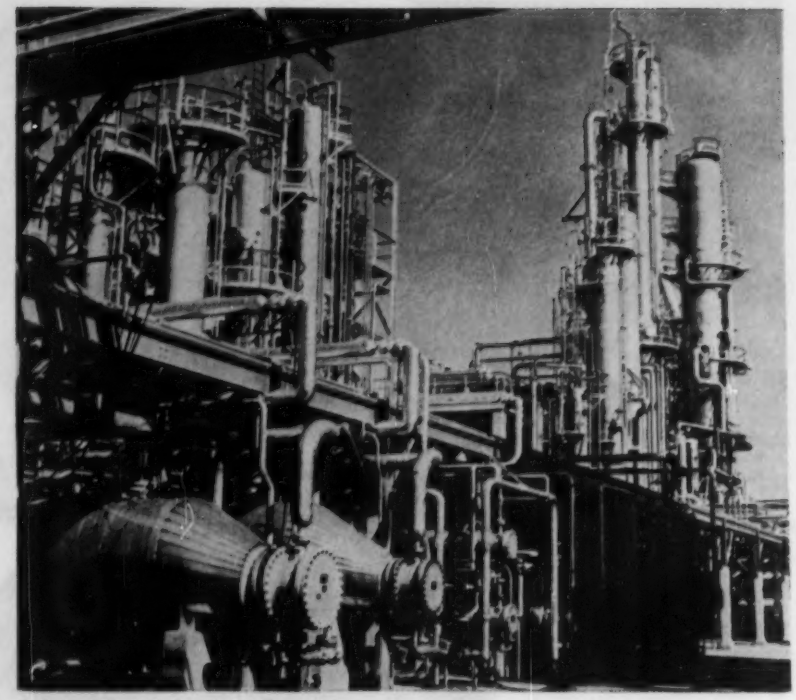
Southwest Gas Producing Company, Inc., is erecting a 1800-barrel-a-day catalytic reformer for integration with other units at a gasoline plant at Dubach, La. The new unit, a Platformer expected to cost $750,000, is scheduled to go on stream in September.

Plans call for using the reformer to upgrade the plant's entire gasoline production to premium and regular octane ratings of 95 and 89 respectively. The contract for building the unit went to The Fisher Engineering Corporation, a Houston company.

Great Northern Oil Company expects to complete its refinery at Pine Bend, Minn., in August. The plant, due to cost $25 million, is being built for a daily capacity of 20,000 barrels.

Completions—

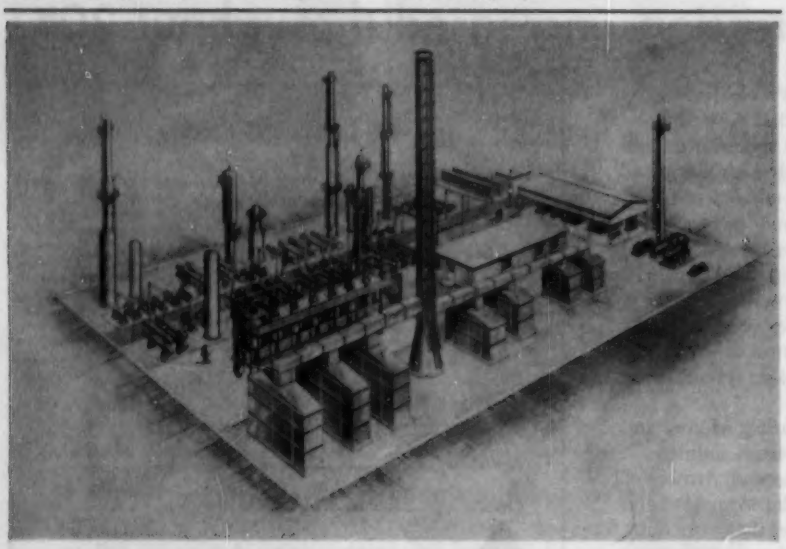
Standard Oil Company of California, which set aside $50 million to expand and modernize its refinery equipment, has completed the two largest units in the program—twin catalytic reformers at the company's refineries in Richmond and El Segundo, Calif. In addition to the two West Coast units, both built for a daily capacity of 22,000 barrels, catalytic-reforming units of lesser capacities are under construction by Standard subsidiaries at Vancouver, B. C., and El Paso, Texas.



Belgian Catalytic Unit Complete—

Gasoline output at the Societe Industrielle Belge des Petroles refinery in Antwerp will be increased by the commissioning of a new catalytic cracker recently completed for a daily capacity of 10,000 barrels. Other improvements at the Belgian refinery, owned jointly by The British Petroleum Company and Cie Financiere Belge de Petroles, S. A., include a newly-installed 3000-barrel-a-day polymerization unit and an existing thermal cracker modified to increase the plant's crude distillation capacity. Both catalytic units, built by The Lummus Company, were designed and licensed by Universal Oil Products Company.

Shell Refining & Marketing Company, Ltd., has put its new 5000-barrel-a-day hydrodesulfurization unit on stream at the Stanlow refinery, near Cheshire, England. The unit was built by The Lummus Company.



Pure Plant Installs Reformer—

The Pure Oil Company has awarded a contract for engineering and construction of a 15,000-barrel-a-day catalytic reformer and a 20,000-barrel-a-day feed-preparation unit to The Ralph M. Parsons Company. The new equipment will be installed at the company's 80,000-barrel-a-day Smiths Bluff, Texas, refinery, near Beaumont. The reforming unit will be an Ultraformer. Construction is scheduled to start early this fall, with completion due next spring.

Champlin Refining Company has gone on stream with a new catalytic reforming unit at its refinery in Enid, Okla., and a new fluid catalytic cracking unit will be complete in about three months. The units are part of a $4-million plant improvement program.

The reformer, a Universal Oil Products Company Platforming unit, will upgrade naphtha to a high-grade gasoline. Capacity of the charging stock will be 5000 barrels a day. The catalytic cracker is being installed for a daily capacity of 9000 barrels.

In addition to the reformer and cracker, the refinery will have in operation a polymerization unit, for processing gases from the catalytic or thermal unit into gasoline. A new laboratory building soon will be constructed.

Daikyo Oil Company, Ltd., has placed on stream a new Houdriflow catalytic-cracking unit at its refinery in Yokkaichi, Japan. The unit, the first of its kind to be built in the Far East, was designed to process 4200 barrels a day of gas oil into high-octane gasoline. Engineering for the new unit was furnished by Houdry Process Corporation, and engineering was handled by a Japanese firm.

The British Petroleum Company has placed a sixth Platformer on stream. The new unit, of 6000-barrel-a-day capacity, went into operation at the affiliated National Oil Refineries, Ltd., plant in Llandarcy, Wales. A seventh Platformer, at the Port Marghere refinery in Venice, is under construction. The new Italian unit, to be rated for 1750-barrels a day, is being built for British Petroleum's Azienda Generale Italiana Petroli. The unit at

HUDSON Solo-aire and Combin-aire COOLING UNITS

minimize water consumption in the Pegasus Plant of Magnolia Petroleum Company, Midland County, West Texas

Pictured in the foreground is the HUDSON Combin-aire unit, with Solo-aire units in the background. Air is used directly for cooling in the Solo-aires where low temperatures are not required. The Combin-aire uses a small quantity of water to precool the air so that entering hot fluids may be cooled to effluent temperatures lower than those obtainable by direct use of air.

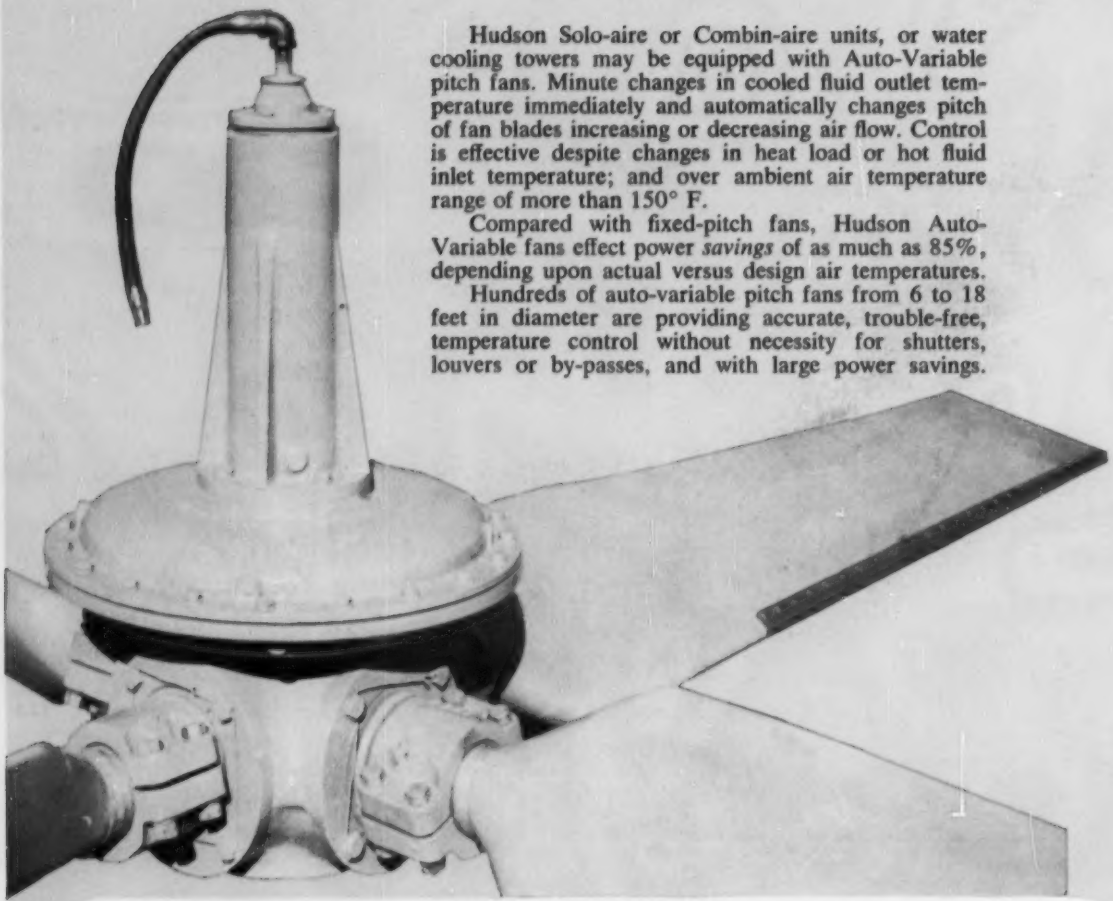
If the total heat load of this plant had been dissipated thru a conventional cooling tower, 158 million gallons of water per year would have been required for makeup. The actual annual water makeup for the plant is only 17 million gallons per year. In this plant the use of the Solo-aire and Combin-aire have proven advantageous, resulting in savings in first cost, in operating costs for horsepower, water treating, and maintenance, and in obviating necessity for drilling of several water wells. Savings in cost of piping result thru installing the Combin-aire in close proximity to process equipment, made possible because the effluent high temperature air is always under-saturated with water vapor and nuisance and high maintenance cost due to water carryover or condensation are eliminated.

New bulletin
"Cooling with Air"
mailed upon request

HUDSON
ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS

Accurate, Automatic Temperature Control



Hudson Solo-aire or Combin-aire units, or water cooling towers may be equipped with Auto-Variable pitch fans. Minute changes in cooled fluid outlet temperature immediately and automatically changes pitch of fan blades increasing or decreasing air flow. Control is effective despite changes in heat load or hot fluid inlet temperature; and over ambient air temperature range of more than 150° F.

Compared with fixed-pitch fans, Hudson Auto-Variable fans effect power *savings* of as much as 85%, depending upon actual versus design air temperatures.

Hundreds of auto-variable pitch fans from 6 to 18 feet in diameter are providing accurate, trouble-free, temperature control without necessity for shutters, louvers or by-passes, and with large power savings.

HUDSON AUTO-VARIABLE PITCH FANS

- **Accurately control temperature.**
- **Effect major savings in power.**
- **Reduce cost of control equipment.**
- **Eliminate by-pass piping.**
- **Prevent freezing even in extremely cold weather.**
- **Operate with standard pneumatic instruments.**
- **Have all moving parts of control mechanism completely enclosed and weather-proofed.**

Hudson designs and manufactures cooling systems using water exclusively, air exclusively, and combinations of air and water. Objective comparisons are furnished without cost.

Hudson Auto-Variable Pitch Fan is protected by U. S. patents and patents pending.

HUDSON
ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS

Llandarcy was designed to produce a 90 F-1 clear motor-fuel blending compound from naphtha derived from Itanian and Kuwait crudes. Universal Oil Products Company designed, engineered and licensed this and the five other Platformers in operation. Procon (Great Britain), Ltd., built the Llandarcy plant.

Societe Per Azioni Raffineria Padana Olii Minerali is nearing completion on an expansion of its refinery at San Martino di Trecate. Work at the 13,300-barrel-a-day Italian plant is scheduled for completion this summer.

New installations at the refinery, half-owned by Caltex Oil Products Company, will include a catalytic cracker built for a daily capacity of 2880 barrels, a vacuum unit with a 5150-barrel-a-day capacity, and a 315-barrel-a-day polymerization unit.

Texas Eastman Starts Expansion of Oxo Plant

PRODUCTION of chemicals in the "butyl family," used primarily in the field of plastics, will be increased at the Longview, Texas plant of Texas Eastman Company. An expansion of the Oxo facilities has been approved and already is under way. The increase will provide adequate capacity for manufacture of butyl and derivatives, such as 2-ethyl hexanol. Other chemicals produced will include propyl aldehydes and derivatives, anyl aldehydes and derivatives and decyl alcohols.

Provision also is being made for modification of some of the auxiliary equipment to permit rapid expansion of facilities manufacturing neopentyl glycol and trimethyl pentanediol. The new facilities at Longview are expected to be in operation by late fall of this year.

The first units of the Oxo plant went into production in the spring of 1952. Utilizing propylene obtained by cracking East Texas liquified petroleum gas, these units have been producing both n- and iso-butyraldehydes which are starting points for a number of important chemical products.

N-butyraldehyde itself is an important raw material in the manufacture of safety glass. Butyric acid, a derivative, is one of the starting points for cellulose acetate butyrate for use in films, plastics and protective coatings. Through processing, n-butyraldehyde is converted to 2-ethyl hexanol, from which a popular vinyl plasticizer is produced.

Iso-butyraldehyde is used as starting point for the manufacture of pantothenic acid. Its derivatives also include isobutyl alcohol and isobutyl acetate, which find wide usage as solvents.

New Facilities Already Outgrown—

Texas Eastman Company's expansion of its three-year-old Oxo facilities at Longview, Texas, will center around such equipment as this. The plant's Oxo reactor appears in the background.

Who's Building . . .

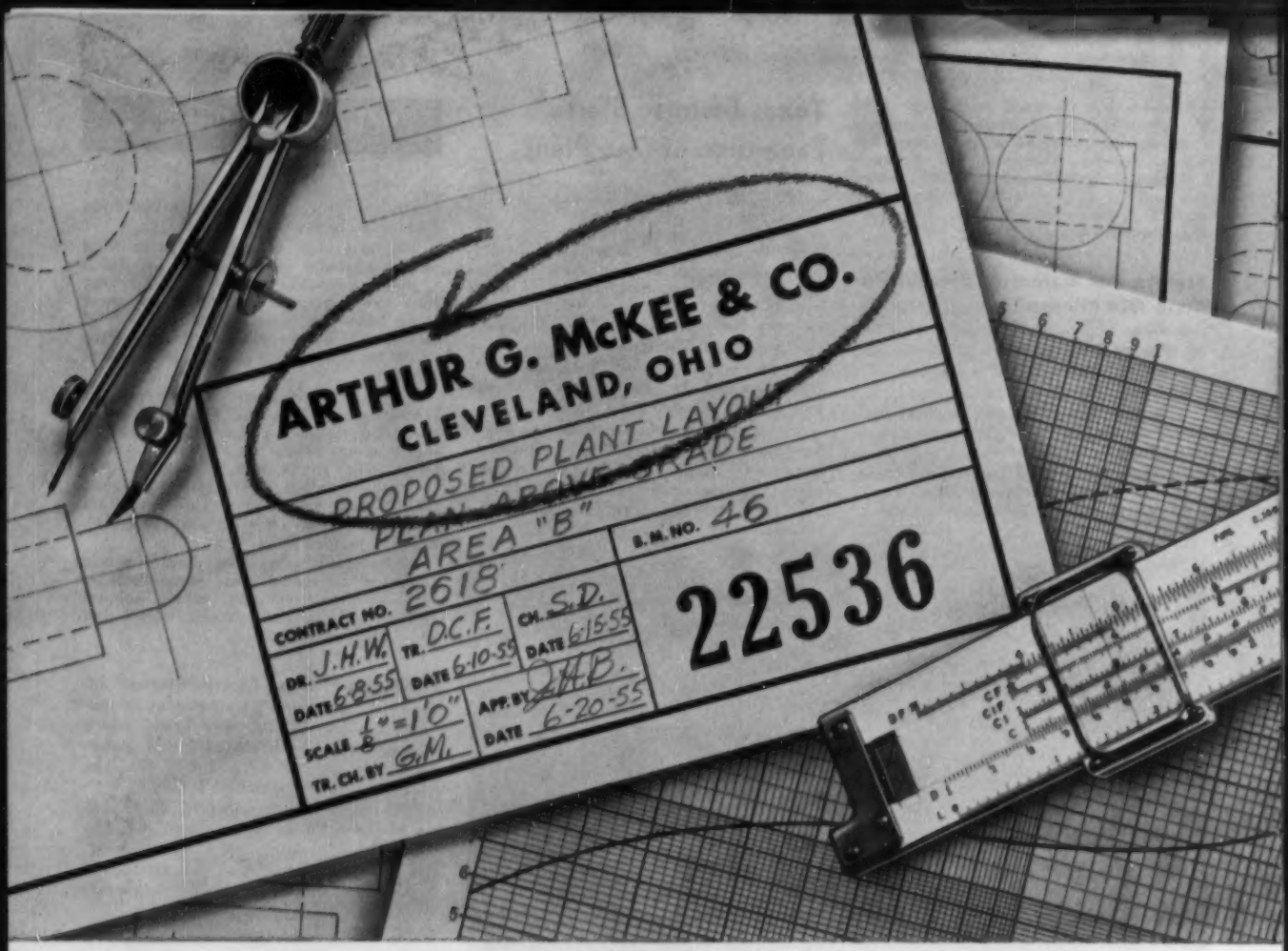
Lone Star Gas Company has installed a butane-splitter column at its gasoline plant at Springtown, Texas, which will step up production of liquid hydrocarbons by some 8000 gallons a day. The new unit cost an estimated $60,000.

The butane splitter will produce an estimated 6000 gallons of iso-butane and 15,000 gallons of commercial butane daily. Installation of the splitter column started in May and was scheduled for completion by July 1.

Bitumen & Oil Refineries, Ltd., has gone on stream with a new Unifining unit at its refinery in Matraville, New South Wales, completing one phase of an expansion which included increasing the capacity of an existing Platformer at the Australian plant from 1500 barrels a day to 2500 barrels. The new unit, built by refinery personnel, was licensed by Universal Oil Products Company.

Union Oil Company of California has put on stream a new and slightly different kind of refinery at Santa Maria, Calif. The plant costing some $16,500,000, is unusual in that its only finished products are coke and sulfur, actually by-products of its primary process of converting heavy crudes to cracking charge stocks. Other products from the crude are shipped to Union's Oleum, Calif., refinery for further processing. The plant at Santa Maria was built to produce 600 tons of coke a day and 42 tons of sulphur.

Nippon Petroleum Company is nearing completion of a modernization and expansion program at its refinery at Yokohama, Japan. New units built in the program, with their design capacities: crude topping unit, 6750 barrels a day; vacuum distillation unit, 4500 barrels a day; gasoline stabilizer, 2180 barrels a day; fluid catalytic crackng unit, Model IV, with gas



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Who's Building . . .

plant, 5000 barrels a day; propane deasphalting unit, 2890 barrels a day; benzol acetone solvent dewaxing unit, 2177 barrels a day, and clay contacting unit, 560 barrels a day. Nippon Petroleum is owned jointly by California Texas Corporation and Japaneses interests.

Imperial Oil, Ltd., has finished installing $8 million worth of new plant and equipment at its Sarnia, Ont., refinery. The Canadian company has completed a $4-million lubricating-oil blending, packaging and warehouse plant, together with a $3-million mechanical shop and a $1-million inspection laboratory. New automatic devices in the lube-oil plant have doubled production in that department.

Also completed is a major expansion of the company's Montreal refinery. The project included construction of a 41,000-barrel-a-day atmospheric pipe still and an 11,000-barrel-a-day vacuum still, together with additions to the plant's existing catalytic-cracking facilities. Bechtel Corporation, which also is handling construction for Imperial at Ioco, B. C. (see **Planning**), completed the projects at Sarnia and Montreal.

Gulf Oil Corporation has placed a new 10,000-barrel-a-day catalytic-reforming unit on stream at its refinery in Cincinnati. The third of four Platformers being built for Gulf, the unit is processing straight-run gasoline boiling in the range of 180 to 400 F. Similar units have been completed at Toledo and Philadelphia, and a fourth unit is nearing completion at Port Arthur.

Ashland Oil & Refining Company has completed a 6000-barrel-a-day catalytic reformer at its refinery in Catlettsburg, Ky. The new facility, a Houdriformer built by Catalytic Construction Company, is designed to take a full range of naphtha charge for upgrading motor gasolines.

"ECLIPSE" Compressors 2, 3, 4, 6 or 9 Cylinders
"ECLIPSE" Ammonia and F-22 Compressors
Large "ECLIPSE" 9-Cyl. Compressor
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Combined Ammonia Units in 3 Sizes
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Large 4-Cylinder Compressors—Up to 700 Hp

The Texas Company has placed two more Platforming-Unifining units on stream. The largest is a 20,000-barrel-a-day unit at the refinery in Port Arthur, Texas. Its design is similar to the unit which went into operation there last summer. The second new unit is at Texaco's Lawrenceville, Ill., refinery. Both units were built by The Lummus Company and licensed by Universal Oil Products Company.

McColl Frontenac Oil Company has completed a $4-million project, increasing the capacity of its Edmonton, Alba., refinery by 11,000 barrels a day. New process equipment includes a 3000-barrel-a-day thermal cracking unit and a catalytic reformer rated for 12,000 barrels a day. The cracker was built by Canadian Kellogg Company, and the Canadian subsidiary for Procon, Inc., installed the reformer.

Construction Boxscore: Refineries and Other Plants . . .

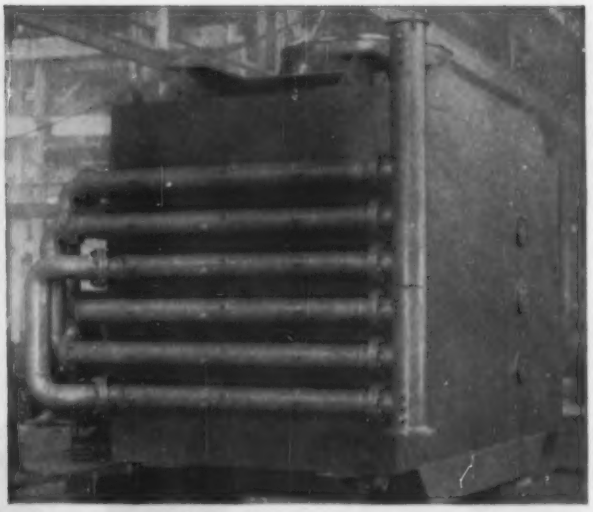
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EAST									
Allied Chem. & Dye	Buffalo, N.Y.	Aromatic Fac.	.....	$6,940,000	PAD Certified	.....	.....	.....	.....
Allied Chemical & Dye Corp.	Moundsville, W. Va.	Hydrogen & Carbon Monoxide Plt.	.....	.....	Engineering	Jan., 1956	.....	Girdler	Girdler
Proctor & Gamble Mfg. Co.	Chicago, Ill.	Hydrogen Plt.	.....	.....	Engineering	May, 1956	.....	Girdler	Girdler
American Oil Co.	Yorktown, Va.	Refinery	35,000 bbls.	$25,000,000	Clearing Site	Late, 1956	.....	Kellogg	Kellogg, Lummus
Ashland Oil & Refining Co.	Catlettsburg, Ky.	Houdriformer	6,000 bbls.	.....	Under Constr.	June, 1955	Houdry	Cat. Constr.	Cat. Constr.
*Atlantic Refining	Philadelphia	Jet-fuel Blending	.....	$450,000	ODM Approved	.....	.....	.....	.....
California Oil Co.	Perth Amboy, N.J.	Crude Desalter	30,000 bbls.	$125,000	Under Constr.	Oct., 1955	Howe-Baker	.....	.....
Columbia-Southern Chemical Corp.	Natrium, W. Va.	Anhydrous Ammonia Plt.	.....	$3,000,000	Under Constr.	April, 1955	.....	.....	.....
*Commerce Oil Ref.	Portsmouth, R.I.	Refinery, Cat. Cracking Crude Units	30,000 bbls. 25,000 bbls. 40,000 bbls.	$30,000,000	Planning	Early, 1957	.....	Lummus	.....
Du Pont	Belle, W. Va.	Ammonia Plt.	.....	$4,000,000	Under Constr.	.....	.....	.....	.....
Du Pont	Parlin, N.J.	Polyester Film Base	.....	.....	.....	.....	.....	.....	.....
Du Pont	Parkersburg, W. Va.	Tetrafluoroethylene Expan.	.....	.....	.....	.....	.....	.....	.....
Du Pont	Niagara Falls, N.Y.	Adiponitrile Unit Expans.	.....	.....	.....	.....	.....	.....	.....
Du Pont	Louisville, Ky.	Inc. Fluorinated Hydrocarbon Capacity	.....	.....	Under Constr.	4th Qtr., 1955	.....	.....	.....

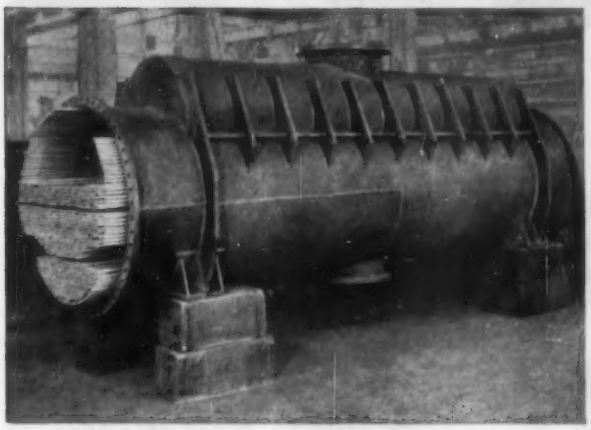
For more data on advertised products, use Readers' Service Cards, last page.

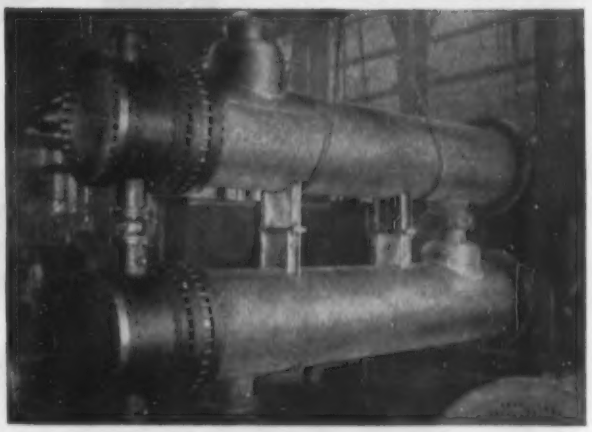
REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*Elk Refining	Falling Rock, W. Va.	Unifiner	1,000 bbl.	$150,000	Completing	July, 1955	U.O.P.		Staff
Escambia Bay Chemical Corp.	Pensacola, Fla.	Ammonia, Nitrogenous Fertilizer Plt.		$25,000,000	Under Constr.	Early 1956			Chemico
Esso Standard Oil Co.	Baltimore, Md.	Fixed Bed Hydroformer	2,000 bbls.		Complete			SOD & Contractor	Foster Wheeler
Esso Standard Oil Co.	Baltimore, Md.	Hydrofinishing Equip.	17,000 bbls.		Complete			SOD & Contractor	Foster Wheeler
Esso Standard Oil Co.	Baltimore, Md.	Fluid Coker	10,000 bbls.		Complete			SOD & Contractor	Bechtel
Esso Standard Oil Co.	Linden, N.J.	Convert Blending Syst. to Semi-Automatic		$2,120,000	ODM Cert.	3rd Qtr., 1955	S.O.D.	S.O.D.	Staff
Esso Standard	Linden, N.J.	Cat. Poly. Plt.	9,100 bbls.		Complete			S.O.D., Braun	Braun
*Esso Standard	Bayonne, N.J.	Add. Dewaxing Capacity			Engineering	1st Qtr., 1956	Esso Research & Eng.		
Esso Standard Oil Co.	Everett, Mass.	Desalters	25,000 bbls.	$612,000	ODM Cert.	4th Qtr., 1955		S.O.D.	Petrolite
Frontier Refining Co.	Fort Pierce, Fla.	Refinery	15,000 bbls.	$16,000,000	Planning				
The Girdler Co.	Louisville, Ky.	Catalyst Plt.			Complete			Girdler	Girdler
B. F. Goodrich	Calvert City, Ky.	Chemical Plt.		$8,500,000	Under Constr.			Fluor	Fluor
B. F. Goodrich	Shelton, Conn.	Carbon Dioxide Plt.	25 tons		Under Constr.	July, 1955		Girdler	Girdler
*B. F. Goodrich	Louisville, Ky.	Syn. Rubber			Under Constr.			Staff, Girdler	Girdler
Gulf Oil Corp.	Philadelphia	Sulfur Recovery		$1,100,000	Complete			Parsons	Parsons
*Gulf Oil	Philadelphia	Platformer	16,000 bbls.		Complete		U.O.P.		
		Two Units to Upgrade Furnace Oils	20,000 bbls. Each		Planning		Gulf		Kellogg
*Ketrona Chemical	Tarrant, Ala.	Ammonia Nitrate of Ammonia Plt.			Planning	1956		Fluor	Fluor
Miami Oil & Refining Co.	West Palm Beach, Fla.	Refinery	15,000 bbls.	$12,000,000	Planning				
Monsanto Chemical Co.	Springfield, Mass.	Styrene Compounding	30,000,000 lbs./yr.	$3,500,000	Complete			Monsanto	Adams & Ruxton
Monsanto Chemical Co.	Springfield, Mass.	Research Fac.		$1,117,000	Complete			Monsanto	D. O'Connel
*Monsanto Chemical	Springfield, Mass.	Polyvinyl Chloride Resins Plt.	26,000,000 lbs./yr.	$2,040,000	Planning	1st Qtr., 1956		Staff	
		Nitric Acid Plt.	60 ton/yr.		Planning	1956		Fluor	Fluor
Northern Chemical Industries	Louisville, Ky.	Ammonia	125 tons	$9,000,000	Under Constr.	2nd Qtr., 1956	Texaco	Girdler	Girdler
		Nitric Acid	60 tons		Under Constr.		Du Pont	Girdler	Girdler
		Nitrogen			Under Constr.			Girdler	Girdler
*Northern Chemical	Searsport, Me.	Sulfuric Acid Plt.	100 tons		Planning	Jan., 1956			
*The Pensoil Co.	Rousseville, Pa.	Platformer-Unifining			Considering		U.O.P.		
Pontiac Eastern Corp.	Lumberton, Miss.	Refinery	12,000 bbls.	$10,000,000	Planning				
Sinclair Refining Co.	MarcusHook, Pa.	Crude Stills	120,000 gals.	$12,700,000	Under Constr.	May, 1956		Parsons	Parsons
*Sinclair Refining	Marcus Hook, Pa.	Desulfurization	10,000 bbls.	$3,800,000	Under Constr.	Jan., 1956		Parsons	Parsons
Socony-Vacuum Oil	Paulsboro, N.J.	Sova former	20,000 bbls.		Under Constr.	July, 1955	Soc.-Vac.	Fluor	Fluor
*Spencer Chemical	Vicksburg, Miss.	Addl. Nitrogen Facl.		$1,500,000	Under Constr.	Early, 1956		Staff	Quaker
Spencer Chemical	Henderson, Ky.	Petrochemical		$1,750,000	Completing	July, 1955		Staff	Quaker
*Stauffer Chemical	Mobile, Ala.	Carbon Bisulfide Plt.			Planning	Spring, 1956			
Sun Oil Company	Marcus Hook, Pa.	Houdriflow Cat. Crker.	27,000 bbls.	$7,500,000	Complete		Houdry	Cat. Constr., Sun	Cat. Constr.
Sun Oil Company	Marcus Hook, Pa.	Houdriformer Cat. Unit	18,000 bbls.	$4,500,000	Complete		Houdry	Sun	Cat. Constr., Sun
Sun Oil Company	Marcus Hook, Pa.	Vacuum Unit	22,000 bbls.	$1,500,000	Complete			Sun, Cat. Constr.	Cat. Constr.
Sun Oil Co.	Marcus Hook, Pa.	Ammonia Plt.	300 tons	$9,000,000	Under Constr.	Nov., 1955		Cat. Constr.	Cat. Constr.
Tennessee Gas Transmission	Isola, Miss.	Compressor Sta.	5500 HP.		Under Constr.	July, 1955		Staff	Olsen
Tide Water Associated Oil	Wilmington, Del.	Refinery	130,000 bbls.	$100,000,000	Under Constr.	End, 1956		Braun, Kellogg	
Union Carbide & Carbon Corp.	Leaksville, N.C.	Dynel Fiber Plt.		$30,000,000	Planning	1955		Staff	
Union Carbide & Carbon	Niagara Falls, N.Y.	Research Lab.		$1,957,229	ODM Cert.				
Westvaco Chlor-Alkali Div.	South Charleston W. Va.	Anhydrous Ammonia Plt.	60 tons			Late 1955			Lummus
MID-CONTINENT									
Amerada Pet. Corp.	Williston Basin, N.D.	Natural Gasoline Plt.		$10,000,000	Planning				
Atlas Powder Co.	Site Undetermined	Ammonia Plt.		$6,750,000	ODM Certified				
Atlas Powder Co.	Site Undetermined	Glycerin Plt.		$5,940,000	ODM Certified				
Aurora Gasoline	Detroit, Mich.	Basic Refining		$400,000	Announced				
Calumet Nitrogen Products Co.	Hammond, Ind.	Ammonia Nitrogen Fertilizer	300 Tons		Under Constr.	May, 1956		Fluor	Fluor
Champlin Refining Co.	Enid, Okla.	Expansion: Fluid Cat. Crker.	9,000 bbls.	$4,000,000	Under Constr.	Aug., 1955	Kellogg		Kellogg
		Platformer	5,000 bbls.				U.O.P.		Sweco
*Cities Service Oil	Ponca City, Okla.	Increase Ref.	10,000 bbls.	$2,000,000	Engineering				
Commercial Solvents Corp.	Peoria, Ill.	Enlarge Nitroparaffin Derivatives Fac.			Planned				
*Continental Oil	Ponca City	Dairy-Wax Plt.	11,000,000 lbs./yr.	$500,000	Planning	Early, 1956			
Derby Oil	Wichita, Kans.	Platforming Unit		$2,700,000	Under Constr.				
Du Pont	Montague, Mich.	Neoprene Plt.			Planned	4th Qtr., 1956			
DX-Sunray	West Tulsa, Okla.	Expand Cat. Cracking	13500	$300,000	Under Constr.	Aug., 1955		Staff	Staff
DX-Sunray	West Tulsa, Okla.	Delayed Coking	7,000 bbls.	$2,300,000	Under Contr.	Dec., 1955		Kellogg	Kellogg
*D-X Sunray	Tulsa	Delayed Coking	7,000 bbls.	$2,500,000	Under Constr.	Nov., 1955		Kellogg	Kellogg
*El Dorado Refining	El Dorado, Kan.	Cat. Reformer	2,500 bbls.		Planning		U.O.P.		
*Firestone Tire	Akron, Ohio	Expand Syn. Rubber Plt.							
Great Plains Refinery Development Co.	Rapid City, S.D.	Refinery	2,000 bbls.	$3,100,000	Under Constr.	End, 1955		Succop	Succop

Construction Boxscore continued on page 207







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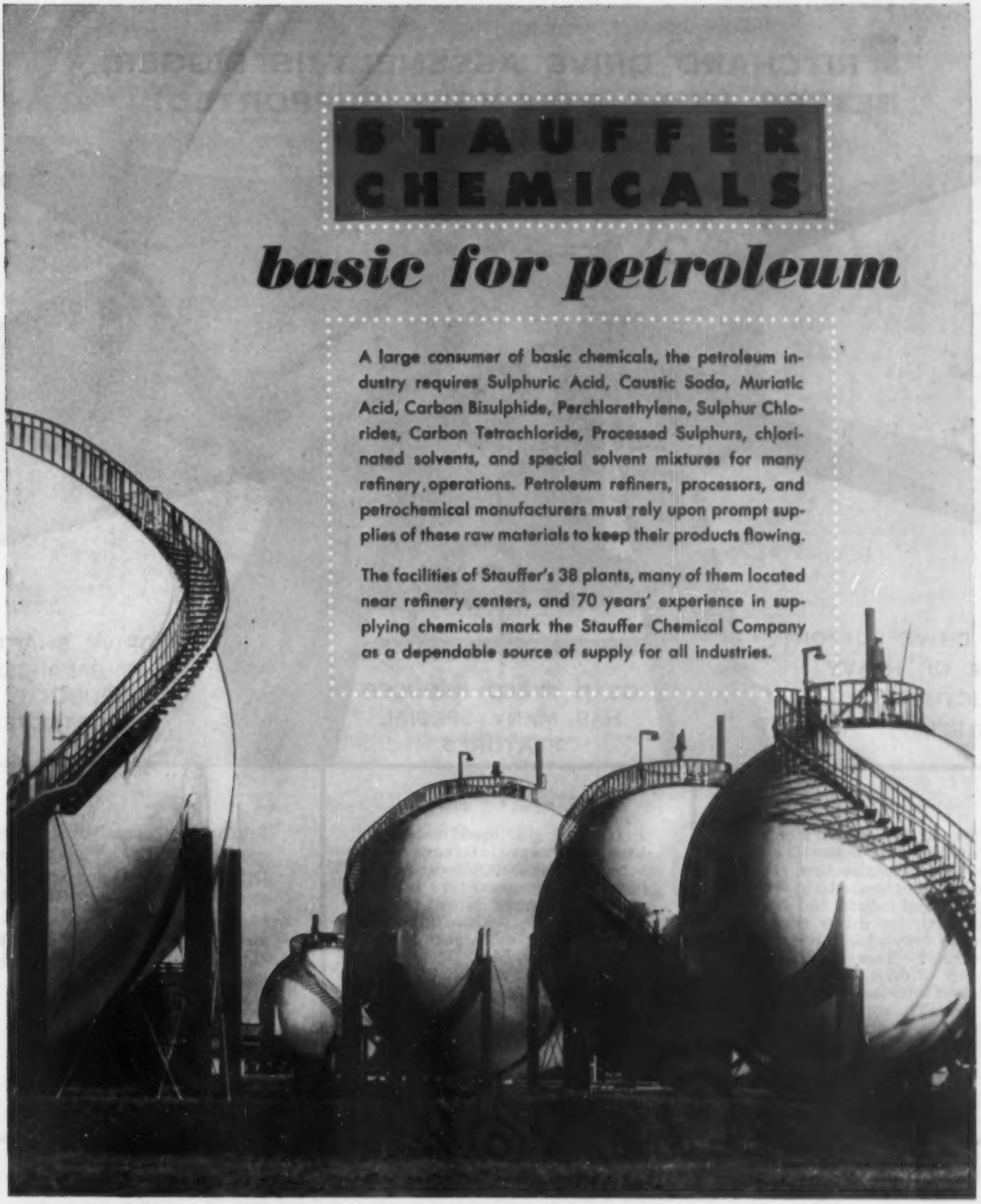
REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Great Northern Oil Company	Pine Bend, St. Paul, Minn.	Crude Topping	25,000 bbls.	.....	.....	.....	.....	Fluor	Fluor
		TCC Unit	12,000 bbls.	.....	.....	.....	Soc-Vac.	Fluor	Fluor
		Ultraformer	5,000 bbls.	.....	.....	.....	Indiana-Standard	Fluor	Fluor
		Hydrodesulfuriser	11,000 bbls.	$25,000,000	Completing	August, 1955	Indiana-Standard	Fluor	Fluor
		Cat. Poly.	900 bbls.	.....	.....	.....	U.O.P.	Fluor	Fluor
		Delayed Coker	460 tons	.....	.....	.....	.....	Fluor	Fluor
Gulf Oil.....	Toledo, Ohio	Platformer	10,000 bbls.	.....	Complete	.....	U.O.P.	Procon	Procon
Gulf Oil.....	Cincinnati, Ohio	Platforming Unit & Aux. Units	10,000 bbls.	.....	Complete	.....	U.O.P.	Procon	Procon
Hercules Powder Co.	Birmingham, Ala.	Anhydrous Ammonia Plt.	45,000 tons/yr.	.....	Planning	1955	.....	.....	.....
International Refineries	Wrenchall, Minn.	Petroleum Refining Fac.	.....	$9,500,000	ODM Approved	.....	.....	.....	.....
*Kimball Gas Products	Kimball City, Neb.	Gasoline Plt.	7.5 Mmcf	$1,000,000	Under Constr.	Aug., 1955	.....	Olsen	Olsen
*Leonard Refineries..	Alma, Mich.	Ultraformer	3,600 bbls.	.....	Planning	.....	.....	Parsons	Parsons
		Hydrofiner	5,200 bbls.	.....	Planning	.....	.....	Pritchard	Pritchard
Mid-West Refineries,	Alma, Mich.	Hydrogenation Unit & Related Fac.	2,500 bbls.	$368,000	Under Constr.	.....	.....	.....	.....
Mississippi Chemical..	Yazoo City, Miss.	Ammonia Plt.	120 tons	$2,000,000	Complete	.....	L'Air Liquide	Girdler, MCC Staff	Girdler, MCC Staff
Mississippi River Fuel Corp.	Crystal City, Mo.	Ammonia Plt & Nitrates	200 tons	$15,000,000	Under Constr.	Oct., 1955	Texaco Dev.	Fluor	Fluor
Naph-Sol Refining Co.	Muskegon, Mich.	Cat. Reformer	6,000 bbls.	.....	Planned	.....	.....	.....	.....
National Distillers	Tuscola, Ill.	Natural Gas Reforming Plt.	.....	.....	Under Constr.	Mid, 1955	.....	Girdler	Girdler
National Petro-Chemicals	Tuscola, Ill.	Polyethylene Facilities	25 million lbs./year	.....	Under Constr.	.....	I.C.I.	Kellogg	Kellogg
*Northwestern Refining	St. Paul Park, Minn.	Cat. Reformer	6,000 bbls.	.....	Planning	May, 1956	.....	.....	.....
Northwestern Refining Co.	St. Paul Park, Minn.	Gas Concentration Unit	.....	.....	Complete	.....	U.O.P.	U.O.P.	Procon
*Olin Mathieson.....	Olin, Ind.	Cellophane Plt.	.....	.....	.....	1956	.....	.....	.....
Pana Refining Co.....	Pana, Ill.	Modernization	†1,600 bbls.	$900,000	.....	.....	.....	.....	.....
Pana Refining.....	Pana, Ill.	Girbotol Unit	.....	.....	Under Constr.	.....	.....	.....	Parker
*Phillips Petroleum...	Kansas City, Kansas	Catalytic Reformer	16,000 bbls.	.....	Planning	Spring, 1956	.....	Procon	Procon
*Phillips Petroleum & Magnolia Petro.	Linsay, Okla.	Nat. Gasoline	.....	.....	Planning	.....	.....	.....	.....
Pontiac Eastern Corp.	South Central, Miss.	Refinery	12,000 bbls.	$10,000,000	Planned	.....	.....	.....	Fluor
Prime Oil Co.....	Calumet City, Ill.	Refinery	15,000 bbls.	$10,000,000	Planned	.....	.....	.....	.....
*The Pure Oil Co.....	Lemont, Ill.	Cat. Reformer	.....	.....	Planning	.....	.....	.....	.....
Sinclair Refining.....	E. Chicago, Ind.	Barrel House Fac.	.....	$2,700,000	Complete	.....	.....	Sinclair	Sumner Sollitt
Sinclair Refining Co...	E. Chicago, Ind.	Cat. Reformer	16,000 bbls.	$13,000,000	Complete	.....	.....	.....	Braun
Sinclair Refining Co...	E. Chicago, Ind.	Cat. Cracking Expan.	.....	$3,252,000	ODM Cert.	.....	.....	.....	.....
*Sinclair Refining.....	East Chicago, Ill.	Carbon-Monoxide Boiler	†30,000 bbls.	.....	Under Constr..	Sept., 1955	.....	B & W	B & W
		Crude Unit			Planning	May, 1956			
*Socony Mobil.....	East Chicago, Ind.	Alkylation			Engineering			Kellogg	Kellogg
		Crude Unit	*30,000 bbls.	.....	Planning	May, 1956	.....	.....	.....
		Polymerization	.....	.....	Complete	.....	U.O.P.	U.O.P.	Procon
Standard-Indiana.....	Whiting, Ind.	Fluid Hydroformer	27,000 bbls.	.....	Complete	.....	.....	.....	Kellogg
Standard-Indiana.....	Whiting, Ind.	Heavy Oils Modern.	.....	.....	Under Constr.	Early, 1956	.....	.....	Foster Wheeler
Standard-Indiana.....	Whiting, Ind.	Crude Unit	55,000 bbls.	.....	Engineering	Early, 1956	.....	.....	Braun
Standard-Indiana.....	Wood River, Ill.	Coking Unit	8,500 bbls.	.....	Planning	1957	.....	.....	.....
Standard-Indiana.....	Wood River, Ill.	Ultraformer	8,000 bbls.	.....	Complete	.....	Standard-Ind.	.....	Kellogg
Standard-Indiana.....	Mandan, N. D.	Ultraformer	5,400 bbls.	.....	Engineering	Late 1956	Standard-Ind.	.....	Parsons
Standard-Indiana.....	Sugar Creek, Mo.	Ultraformer	12,000 bbls.	.....	Under Constr.	Late, 1955	Standard-Ind.	.....	Parsons
*Standard-Indiana....	Seymour, Ind.	Solid Rocket Propellant Pilot Plt.	.....	.....	Under Constr.	July, 1955	.....	.....	.....
Standard (Ohio)	Lima, Ohio	Cat. Polymerisation Unit	.....	$335,000	Under Constr.	Sept., 1955	.....	.....	.....
Standard (Ohio)	Lima, Ohio	Petrochemical Plt: Anhydrous Ammonia	300 tons	$17,000,000	Under Constr.	Nov., 1955	.....	.....	Kellogg
		Nitric Acid.....	60 tons						
		Nitrogen Solution.....	200 tons						
		Offsite Fac.	.....	.....	.....	.....	.....	.....	McKee
		Urea Plt.	120 tons	.....	Designing	Jan., 1956	Vulcan	Vulcan	Vulcan
Standard (Ohio).....	Cleveland, Ohio	Ultraformer	11,000 bbls.	$4,400,000	Engineering	2nd Qtr., 1956	Standard-Ind.	Fluor	Fluor
St. Paul Ammonia Products Co.	Pine Bend, Minn.	Ammonia Plt.	200 tons	$15,000,000	Planning	April, 1956	.....	.....	.....
Sun Oil Co.....	Toledo, Ohio	Houdriflow Cat. Crker.	27,000 bbls.	$6,000,000	Complete	.....	Houdry	Cat. Constr., Sun	Cat. Constr.
The Texas Co.....	Lawrenceville, Ill.	Cat. Reformer	13,631 bbls.	.....	Complete	.....	.....	U.O.P.	Lummus, Others
	Lawrenceville, Ill.	Alkylation Unit	2,253 bbls.	.....	Complete	.....	.....	Lummus, Others	.....
The Texas Co.....	Tulsa, Okla.	Platformer Unit	9,040 bbls.	.....	Under Constr.	3rd Qtr., 1955	.....	U.O.P., Refinery	Refinery & Others
The Texas Co.....	Lockport, Ill.	Platformer	10,854 bbls.	.....	Under Constr.	3rd Qtr., 1955	.....	U.O.P. and McKee	McKee
The Texas Co.....	Lockport, Ill.	Alkylation Plt.	1,000 bbls.	.....	Under Constr.	3rd Qtr., 1955	.....	Staff	.....
Vulcan Asphalt Refining Co.	Cordova, Ala.	Relocation of Refinery	2,200 bbls.	$122,700	ODM Approved	.....	.....	.....	.....
Warren Petroleum Corp.	Antioch, Okla.	Distl. Plt.	.....	$2,800,000	Complete	.....	.....	Gas Plt. Constr.	Gas Plt. Constr.
Warren Petroleum Corp.	Maysville, Okla.	Extraction Enlargement	19,000 bbls.	$2,800,000	Complete	.....	.....	Gas Plt. Constr.	Gas Plt. Constr.
Wisconsin Oil Refining Co.	Sheboygan, Wis.	Vacuum Unit	2,500 bbls.	.....	Planning	.....	.....	Koch	.....
SOUTHWEST									
Allied Chem. & Dye Corp.	Orange, Texas	Ethanolamines	.....	.....	.....	1955	.....	.....	.....
American Republics Corp., et al	Silsbee, Texas	Gaso. Plt.	20 Mmcf	$1,000,000	Under Constr.	Aug., 1955	.....	Braun	Olsen
*Atlantic Refining....	Atreco, Texas	Increase Alkyl.	.....	.....	Completing	.....	.....	.....	.....
		Water Treating	.....	.....	Completing	.....	.....	.....	.....

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*Arkansas Fuel Oil	Panola County, Texas	Cat. Reformer	1,800 bbls.	.....	Engineering	.....	.....	.....	.....
*Celanese	Pampa, Texas	Increase Vinyl-Acetate Facl. Methyl Ethyl Unit	.....	.....	Planning Under Constr.	.....	.....	.....	.....
Chillicothe Petrochemicals, Inc.	Chillicothe, Tex.	Petrochemical Plt.							
		Ammonia	180-200 tons	$12-14,000,000	Unconfirmed	.....	.....	.....	.....
		Urea	150 tons						
*Cities Service	Lake Charles	Ref. Mod. Expan.	.....	.....	Completing	.....	.....	.....	.....
Cities Service, et al	Seminole, Texas	Nat. Gas Plt.	55,000 gals.	.....	Planning	.....	.....	.....	Delta
*Cities Service et al	Midland County, Texas	Nat. Gaso. Plt.	.....	$7 million	Planning	.....	.....	.....	.....
Columbian Carbon Co.	North Bend, La.	Carbon Black Plt.	60,000,000 lbs./yr.	.....	Under Constr.	Nov., 1955	.....	.....	.....
Commercial Solvents Corp.	Sterlington, La.	Nitroparaffins Fac.	10,000,000 lbs./yr.	$5,000,000 (Incl. Peoria, Ill.)	Under Constr.	3rd Qtr., 1955	.....	Staff & Texas	Ford, Bacon & Davis
Cons. Chem. Ind.	Baytown, Tex.	Alky. Sulfuric Acid-Regen. Plt. & Sulfur Burning Acid Plant	600 tons	$4,500,000	Complete	.....	.....	Chemico	Chemico
Cons. Chem. Ind.	Houston	Alky. Sulfur Acid-Regen. Plt.	400 tons	$3,500,000	Complete	.....	.....	Chemico	Chemico
*Cosden Petroleum	Big Spring, Tex.	Cat. Reformer Unit & Superfractionation	3,200 bbls.	$1,950,000	Planned	.....	.....	.....	.....
Corpus Christi Refining Co.	Tucker, Texas	Modernization	.....	.....	Planned	.....	.....	.....	.....
Damaho Refining Co.	Pettus, Texas	TCC Cat Crker. w/Reform.	3,500 bbls.	$2,600,000	Under Constr.	3rd Qtr., 1955	Sec.-Vac.	Koch	.....
		Cat. Poly.	265 bbls.	.....	.....	.....	.....	.....	.....
		Crude Expan. Gas Conc.	7,500 bbls.	.....	.....	.....	.....	.....	.....
Dow Chemical Co.	Velasco, Texas	Glycerin Unit, Polyethylene	.....	$18-20,000,000	Completing	Aug., 1955	.....	.....	.....
Dow Chemical Co.	Freeport, Texas	Soda Ash Plt.	300 tons	$3,000,000	Under Constr.	1955	.....	.....	.....
Eastern States Petroleum Co.	Houston, Texas	Coking Plt.	13,000 bbls.	$4,000,000	Projected	.....	.....	.....	.....
*Eastern States Petr.	Houston	Unifiner	7,000 bbls.	.....	Complete	.....	Union	Staff	Staff
D. D. Feldman Co.	Lake Arthur, La.	Petrochem. Plt.	.....	$843,000	Applied for certificate of necessity	.....	.....	.....	.....
*Firestone Tire	Lake Charles, La.	Expand Synth. Rubber Plt.	.....	.....	.....	.....	.....	.....	.....
*Foster Grant	Baton Rouge, La.	Expand Styrene Monomer Plt.	†50,000,000 lbs./yr.	.....	Planning	.....	.....	.....	.....
*Goodyear Synthetic Rubber	Houston	Copolymer Expansion	†50%	$750,000	Planning	.....	.....	.....	.....
Great Southern Chemical Corp.	Corpus Christi, Texas	Hydrogen Compressor	.....	$94,000	Complete	.....	.....	.....	.....
*Gulf Oil	Port Arthur, Texas	Two Units to Upgrade Furnace Oils	20,000 bbls. Each	.....	Building	Gulf	.....	.....	.....
Gulf Oil	Port Arthur, Texas	Platforming	29,000 bbls.	.....	Complete	.....	U.O.P.	Fluor	Fluor
Gulf Oil	Port Arthur Texas	Crude Topping	100,000 bbls.	.....	Engineering	.....	.....	McKee	McKee
		Catalytic Cracking Unit	68,500 bbls.	.....	Engineering	.....	.....	Kellogg	Kellogg
Gulf Oil	Port Arthur, Texas	Exp. Ethylene Fac.	3,000 Mmcf/yr.	.....	Complete	.....	.....	S&W, Badger Div.	S&W, Badger Div.
Gulf Oil	Port Arthur, Texas	Gas Purification Unit	.....	.....	Complete	.....	.....	Girdler	Girdler
Gulf, Humble and Texas	St. Landry Parish, La.	Cycling & Gasoline Plt.	100 Mmcf	$10,000,000	Complete	.....	.....	.....	.....
Humble Oil & Refining Co.	Baytown, Texas	Clay Treating Unit	12,000	$480,000	Complete	.....	.....	Fluor	Fluor
Humble Oil & Refining Co.	Baytown, Texas	Hydrofining Unit	8,100	$1,525,000	Complete	.....	.....	Braun	Braun
Humble Oil & Refining Co.	Baytown, Texas	Desulfurization Unit	30,875	$800,000	Complete	.....	.....	Lummus	Lummus
Humble Oil & Refining Co.	Baytown, Texas	Hydroformer No. 1	18,000	$4,000,000	Under Constr.	Aug., 1955	.....	Fluor	Fluor
Humble Oil & Refining Co.	Baytown, Texas	Hydroformer No. 2	18,000	$4,100,000	Complete	.....	.....	Kellogg	Kellogg
Humble Oil & Refining Co.	Baytown, Texas	Deresining Unit	.....	$1,630,000	Complete	.....	.....	Humble	Humble
Koppers Co.	Port Arthur, Tex.	Polyethylene Plt.	.....	$4,500,000	Completing	.....	.....	Koppers	Koppers
McBride Refining Co.	Port Brownsville, Texas	Ref. Expan.	†12,500 bbls.	$2,500,000	Planned	.....	.....	.....	.....
McMurrey Refining Co.	Tyler, Texas	Avia. Gaso. Plt.	.....	$3,000,000	Engineering	.....	.....	Blaw-Knox, Kellogg	Blaw-Knox
McMurrey Refg. Co.	Port Brownsville, Texas	Ref. Expan.	†12,500 bbls.	.....	Planned	.....	.....	.....	Kellogg
*Monsanto Chemical	Texas City, Tex.	Methanol Plt.	26,000,000 gal./yr.	$9,000,000	Complete	.....	.....	Kellogg	Kellogg
Monsanto Chemical	Texas City, Tex.	Polyethylene Plt.	25,000,000 lbs./year	$10,000,000	Complete	.....	.....	Monsanto	Farnsworth & Chambers
*North American Petro.	Corpus Christi, Texas	Refinery	.....	$1,000,000	Under Constr.	Late, 1955	Atlantic	.....	.....
		Cat. Reformer	2,000 bbls.					Texas	Beck
Northeast Texas Chemical Co.	East Texas	Chemical and Fertilizer Plt.	.....	.....	Planning	.....	.....	.....	Bowden
*Odessa Natural Gasoline	Ector County Texas	Nat. Gaso. Plt. Expansion	†40 Mmcf	$1,000,500,	Under Constr.	July, 1955	.....	.....	.....
*Petro-Tex Chemical	Houston	Butadiene Expansion	†45,000 tons/yr.	$1,000,000	Planning	.....	.....	.....	.....
*Phillips Petroleum	Andrews, Texas	Nat. Gasoline	33 Mmcf	.....	Planning	.....	.....	.....	.....
Phillips Petroleum Co.	Borger, Texas	Distillate Hydrogenation Unit	10,000 bbls.	$488,000	Under Constr.	Sept., 1955	.....	Procon	Procon
Phillips Petroleum Co.	Borger, Texas	Catalytic Reforming Unit	16,000 bbls.	$5,395,000	Under Constr.	Sept., 1955	.....	Procon	Procon
Phillips Petroleum Co.	Phillips, Texas	Dehydration Unit	.....	.....	Under Constr.	July, 1955	.....	.....	.....
*Phillips Chemical	Sweeney, Texas	Polyethylene	145,000,000 ton/yr.	.....	Planning	.....	.....	.....	.....
*Phillips Chemical	Houston	Polyethylene	.....	.....	Planning	.....	.....	.....	.....
Premier Pet. Co.	Longview, Tex.	Cat. Poly. Plt.	.....	.....	Under Constr.	.....	.....	.....	.....
The Pure Oil Co.	Smith Bluffs, Texas	Cat. Reformer	.....	.....	Under Constr.	Spring, 1956	Standard-Ind.	Parsons	Parsons

Construction Boxscore continued on page 211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REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*Shell Chemical	Norco, La.	Hydrogen Peroxide Offsite Facl.	.....	.....	Engineering	End, 1955	.....	Braun, Fluor	Braun, Fluor
Shell Chemical	Houston	Epon Plt. Exp.	.....	.....	Complete	.....	.....	Lummus	Lummus
*Shell Oil	Houston	Cat. Reformer	16,000 bbls.	.....	Under Constr.	Early, 1956	.....	Procon	Procon
Shell Oil Co.	Norco, La.	Refinery Expan.	175,000 bbls.	$30,000,000	Complete	.....	.....	.....	.....
*Shell Oil Co.	Houston	Cat. Reformer	16,000 bbls.	.....	Under Clonstr.	Early, 1956	.....	.....	Procon
		Hydrodesulfurization Unit	16,000 bbls.	.....	Under Constr.	.....	.....	.....	Procon
*Shell Chemical	Houston	Bisphenol Expan.	.....	.....	Engineering	1st Qtr., 1956	.....	Lummus	Lummus
*Sinclair Refining	Houston	SO_2 Sulfonation	.....	$2,200,000	Under Constr.	Jan., 1956	.....	Badger	Badger
Sinclair Refining	Houston, Texas	Cat. Reformer	24,000 bbls.	$16,500,000	Under Constr.	April, 1956	Sinclair	Kellogg	Kellogg
Standard Oil Co. of Texas	El Paso, Texas	Platformer	4500 bbls.	$2,700,000	Under Constr.	Aug., 1955	U.O.P.	Bechtel	Bechtel
*Southwest Gas	Dubach, La.	Reforming Unit	1,800 bbls.	$750,000	Under Constr.	Nov., 1955	.....	.....	Fish
*Southwestern Oil & Refining	Corpus Christi, Texas	Refining Facl.	8,000 bbls.	$2,195,000	Planning	Feb., 1956	.....	.....	.....
Stanolind Oil & Gas Co.	Ector County, Texas	Gas Comp.	.....	$209,000	ODM Cert.	.....	.....	.....	.....
Stanolind Oil & Gas	Brownsville, Texas	Recondition & Revamp	.....	.....	Under Constr.	Fall, 1956	.....	Lummus	Lummus
Sunray Mid-Continent	Branch, La.	Cycling & Gaso. Plt.	24 Mmcf	$1,500,000	Under Constr.	Dec., 1955	.....	.....	.....
*Sunray Mid-Continent	Chruch Point, La.	Nat. Gaso. Plt.	.....	.....	Under Constr.	.....	.....	.....	.....
*Sunray Mid-Continent	Nueces County, Texas	Nat. Gaso. Plt.	.....	.....	Planning	.....	.....	.....	.....
Suntide Refining Co.	Corpus Christi, Texas	Alkyl. Expan.	To 70,000 bbls.	.....	Projected	.....	.....	.....	.....
The Texas Co.	Port Arthur, Texas	No. 2 Catalytic Reformer	20,000 bbls.	.....	Complete	.....	.....	Staff, U.O.P. and Others	Lummus and Others
Texas Butadiene & Chemical Corp.	Settegast, Texas	Aviation Alkylate, Butylenes & Butadiene	5,000 bbls.	$29,500,000	Planned	.....	.....	.....	Fluor
Texas Natural Gasoline Corp.	Coke County, Texas	Gathering System & Nat. Gaso. Plt.	70 Mmcf	.....	Under Constr.	Oct., 1955	.....	Fluor	Fluor
ROCKY MOUNTAIN									
Arizona Refineries	Coolidge, Ariz.	Refinery	25,000 bbls	Part of $100,000,000 Project	Planning	Jan., 1956	.....	Ebasco Services	.....
Atlantic Refining Co.	Lovington, N.M.	Natural Gas	25 Mmcf.	.....	Projected	.....	.....	.....	.....
*Big West Oil	Kevin, Mont.	Cat. Reformer	1,000 bbls.	$500,000	Under Constr.	Oct., 1955	U.O.P.	Procon	Procon
Jack Bishop Group	Phoenix, Ariz.	Refinery	5,000 bbls.	$6,000,000	Proposed (Unconfirmed)	.....	.....	.....	.....
*Black Thunder Oil	Clareton Field, Wyo.	Nat. Gaso. Plt.	5 Mmcf	$400,000	Complete	.....	.....	Russell	Russell
Continental Sulphur & Phosphate Corp.	Thermopolis, Wyoming	Sulfur Extraction	50 tons/yr.	.....	Under Constr.	.....	American Sulfur & Refining	.....	Chemico
Cullen Group	Newcastle, Wyo	Gas Plt.	.....	$4,500,000	Planned	.....	.....	.....	.....
Famariss Oil & Refining Co.	Monument, N. M.	Cat. Reforming Unit	650 bbls.	$375,000	Scheduled	.....	U.O.P.	U.O.P.	Famariss Oil & Refining Co.
First National Petroleum Corp.	Jensen, Utah	Ref. Expan.	To 3,000 bbls.	.....	Planned	.....	.....	.....	.....
Frontier Refining Co.	Cheyenne, Wyo.	Ref. Expan.	17,500 bbls.	$1,500,000	Under Constr.	Summer, 1955	U.O.P.	U.O.P.	Procon
Navajo Refineries	Albuquerque, N. M.	Refinery	10,000 bbls.	Part of $100,000,000 Project	Planning	Jan., 1956	.....	Ebasco Services	.....
*Oriental Refining	Denver, Colo.	Thermal Crkr.	.....	.....	Rebuilding	.....	.....	.....	.....
Pure Oil Co., et al.	Adena Field, Colo.	Nat. Gaso. Plt.	20 Mmcf	$3,000,000	Under Constr.	July, 1955	.....	.....	Stearns-Roger
Salt Lake Refining Co.	Davis County, Utah	Catalytic Cracking Unit	4,100 bbls.	$3,330,000	ODM Certified	.....	S.O.D.	Fluor	Fluor
Salt Lake Chemical Co.	Salt Lake City, Utah	Synthetic Ammonia Plt.	120 tons of Ammonia 30 tons dry ice.	$7,800,000	Planned	.....	.....	Tears	Tears, Henry C. Beck Co.
Sioux Oil Co.	Newcastle, Wyo.	Expan. of Two Refineries	5,000 bbls.	Part of $4,000,000 project	Planning	1955	.....	Pervin & Gurts	.....
*Skelly Oil	Denver	Cat. Reformer	.....	.....	Under Constr.	.....	.....	.....	.....
Standard-Indiana	Casper, Wyo.	Heavy Oils, Mod. & Expan.	.....	.....	Planning	1957	.....	.....	.....
*The Texas Co.	Casper, Wyo.	Cat. Reformer	4,800 bbls.	.....	Engineering	Early, 1956	U.O.P.	Fluor	Fluor
Union Oil Co. (Calif.)	Rifle, Colo.	Shale Oil Pilot Plt.	.....	$5,000,000	Planning	.....	.....	Stearns-Rogers	.....
U. S. Steel Corp.	Geneva, Utah	Anhydrous Ammonia	200 tons	$20,000,000	Planned	1956	.....	Blaw-Knox	Blaw-Knox
Utah Chemical Co.	Sanpete Valley, Utah	Ammonia Plt.	276 tons	$16,800,000	Planned	End, 1955	.....	.....	Cat. Constr.
Utah Oil Refining	Salt Lake City, Utah	Ultraformer	5,500 bbls.	$3,000,000	Planning	March, 1956	Standard-Ind.	Fluor	Fluor
Valley Gas Corp.	Lea County, N. M.	Nat. Gaso. Plt.	5 Mmcf	.....	Complete	.....	.....	F. S. West	F. S. West
Western States Refg.	Salt Lake City	Topping; Crker.	2,000/2,200 bbls.	$1,100,000	.....	.....	.....	.....	.....
WEST COAST									
Brea Chemicals, Inc.	Brea, Calif.	Nitric Acid & Ammonium Nitrate Plt.	137 tons	$3,000,000	Under Constr.	Aug. 1955	.....	C & I	C & I, Macco
California Stray Chemical	Richmond, Calif.	Fertilizer Plt.	.....	$3,000,000	Planning	Mid-1956	.....	.....	.....
Calstate Refg. Co.	Signal Hill, Calif.	Hyperformer Unit	1,100 bbls.	$300,000	Under Constr.	.....	Union Oil	.....	Calstate
Caminol	Hanford, Calif.	Petroleum Refining Fac.	.....	$1,600,000	ODM Approved	.....	.....	.....	.....
Carbide & Carbon Chemicals Company	Torrance, Calif.	Polyethylene Plt.	60 million lbs./yr.	$36,000,000	Under Constr.	End, 1955	.....	.....	.....
Columbia River Chemicals	Pasco, Wash.	Anhydrous Ammonia	160 tons	$12,000,000	Under Constr.	Late 1955	.....	Fluor	Fluor
		Urea	110 tons						
		Ammonium Sulfate	140 tons						
Du Pont	Antioch, Calif.	Fluorinated Hydrocarbons.	.....	.....	.....	.....	.....	.....	.....
Fletcher Oil Co.	Wilmington, Calif.	Topping Unit	10,000 bbls.	$976,000	ODM Cert.	.....	.....	.....	.....
*General Petroleum	Ferndale, Wash.	Refinery Expan. Pretreaters, Boilers, Soverformer	.....	$5,600,000	Under Constr.	1956	.....	E & A	E & A

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Hancock Oil Co.	Signal Hill Calif.	Fluid Coking Unit	6,000 bbls.	$1,814,800	ODM Certified	.....	.....	.....	.....
Hancock Oil Co.	Long Beach	Cat. Reformer	2,500 bbls.	$550,000	ODM Certified	.....	.....	.....	.....
Pacific Oil & Refining Co.	Tacoma, Wash.	Refinery	10,000 bbls.	.....	Under Constr.	.....	.....	.....	.....
*Richfield Oil	Watson, Calif.	Cat. Reformer	17,000 bbls.	.....	Planning	Mid-1956	Sinclair-Bakers	Parsons-Staff	Parsons
Rothschild Oil	Santa Fe Springs, Calif.	Cat. Crker.	6,000 bbls.	$2,000,000	.....	.....	.....	.....	Braun
Shell Chem. Corp.	Martinez, Calif.	Ionol Plt. Exp.	.....	.....	Under Constr.	3rd Qtr., 1955	.....	Staff	Staff
Shell Oil	Anacortes, Wash.	Refinery	50,000 bbls.	$75,000,000	Under Constr.	End, 1955	.....	Bechtel	Bechtel
Signal Oil & Gas	Los Angeles, Calif.	Butanes-Isobutane	.....	$500,000	.....	.....	.....	.....	.....
Standard (Calif.)	Richmond, Calif.	Ammonia Plt.	300 tons	$12,800,000	Planning	Mid-1956	.....	.....	.....
Standard (Calif.)	Richmond, Calif.	Nitric Acid Plt.	225 tons	.....	Planning	Mid-1956	.....	.....	.....
Standard (Calif.)	Richmond, Calif.	Isophthalic Plt.	50 mln. lbs./yr.	$10,900,000	Engineering	Nov., 1955	.....	Staff	Ferguson
Standard (Calif.)	Richmond, Calif	Cat. Reformer	20,000 bbls.	.....	Complete	.....	.....	Bechtel	Bechtel
	El Segundo, Calif.	Cat. Reformer	.....	$30,000,000	Complete	.....	.....	Bechtel	Bechtel
Standard Oil (Calif.)	El Segundo, Calif.	Offsite Fac.	.....	.....	Complete	.....	.....	Fluor	.....
Standard Oil (Calif.)	Honolulu	Refinery	20-30,000 bbls.	$25-30,000,000	Planned	.....	.....	.....	.....
Stauffer Chemical	Compton, Calif.	Sulfuric Acid	.....	$57,070	Engineering	.....	.....	.....	.....
Stauffer Chemical	Richmond, Calif.	Sulfuric Acid	.....	$283,500	.....	.....	.....	.....	.....
Sunset Oil Co.	Portland, Ore.	Refinery	20,000 bbls.	.....	Considering	.....	.....	.....	.....
The Texas Co.	Wilmington, Calif.	Platforming	10,000 bbls.	.....	Complete	.....	.....	U.O.P., Braun & Others	Braun & Others
The Texas Co.	Wilmington, Calif.	Hydrotreating	10,000 bbls.	.....	Complete	3rd Qtr., 1955	.....	U.O.P., Braun & Others	Braun & Others
The Texas Co.	Wilmington, Calif.	Isomerization	1,000 bbls.	.....	Complete	.....	.....	Staff	Staff
*The Texas Co.	Wilmington, Calif.	Furfural Unit	25,000 bbls.	.....	Under Constr.	1st Qtr., 1956	.....	Staff	.....
*Tide Water Associated	Avon, Calif.	Refinery Expan. Add Coker, Gas Plt. Hydrodesulfurizer, enlarge Cat. Cracking	.....	.....	Planning	.....	.....	.....	.....
Union Oil (Calif.)	Los Angeles	Fac. for Handling Enriched Crude	.....	$950,000	Engineering	.....	.....	Fluor	Fluor
Union Oil Co. (Calif.)	Los Angeles	Gas, Oil & Heavy Side Cut Strippers	.....	$250,000	Planning	.....	.....	Fluor	Fluor
*Union Oil (Calif.)	Los Angeles	Lube-Oil Bldg.	.....	$2,000,000	Under Constr.	Jan., 1956	.....	Bechtel	Bechtel
OUTSIDE U.S.A.									
Canada									
*British American Oil	Clarkson, Ont.	Cat. Reforming	.....	.....	Planning	.....	.....	.....	.....
*British American Oil	Moose Jaw, Sask.	Cat. Reforming	.....	.....	Planning	.....	.....	.....	.....
*British American Oil	Edmonton, Alta.	Cat. Reforming	.....	.....	Planning	.....	.....	.....	.....
British-American Oil Co.	Calgary	Cat. Reformer	2,000 bbls.	.....	Complete	.....	Atlantic	Fluor	Fluor
British-American Oil Co.	Montreal	Cat. Reformer	13,000 bbls.	$3,000,000	Under Constr.	Late, 1955	Atlantic	Lummus	Lummus
British Dominion Oil Co.	Southern Alberta, Canada	Ammonium Nitrate	.....	$1,800,000	Planning (Unconfirmed)	.....	.....	.....	.....
Can-Amera Oil-Sands Development, Ltd.	Edmonton, Alta.	Processing Plt.	.....	.....	Unconfirmed	.....	.....	.....	.....
*Can-Amera Oil Sands	Bitumount, Alta.	Oil-Sands Separat on Plt.	500 bbls.	$300,000	Under Constr.	Sept., 1955	.....	.....	.....
*Canadian Gulf Oil	Alberta	Nat. Gaso. Plt.	.....	$2,000,000	Planning	.....	.....	Mannix Gill	Mannix Gill
Canadian Hydrocarbons, Ltd.	Winnipeg, Manitoba	Ammonia Plt.	.....	.....	Planning (Unconfirmed)	.....	.....	.....	.....
*Canadian Industries (1954)	Millhaven, Ont.	Anhydrous Ammonia Plt.	200 ton	$9,000,000	Under Constr.	Mid, 1956	.....	.....	.....
Canadian Industries, (1954) Ltd.	Milhaven, Ont.	"Terylene" Plt.	11,000,000 lbs./yr.	$20,000,000	Complete	.....	.....	Ferguson	Ferguson
Canadian Oil Companies, Ltd.	Sarnia, Ontario	Carbon Monoxide Steam Generator	.....	$400,000	.....	Oct., 1955	.....	.....	Combustion Engineering
Canadian Petrofina, Ltd.	Montreal, Quebec, Canada	Refinery	20,000 bbls.	$20,000,000	Under Constr.	Late 1955	Houdry, Standard of Ind., Kellogg, Standard of N.J.	.....	Canadian Kellogg & Lummus
Canada Southern Oils	Saskatchewan	Refinery	10-20,000 bbls.	$7,000,000-$10,000,000	.....	.....	.....	.....	.....
Consolidated Mining & Smelting of Canada	Calgary, Alta.	Urea Plt.	.....	.....	Considering	.....	.....	.....	.....
Davison Chemical Company	Valleyfield, Quebec	Synthetic Fluid Cracking Cat-Catalyst Plt.	.....	$6,000,000	.....	.....	.....	Stone & Webster	.....
Ethyl Corporation of Canada, Ltd.	Sarnia, Ont.	Anti-Knock Compound Plt.	.....	.....	Planning	Early, 1956	.....	.....	.....
Excelsior Refineries, Ltd.	Dawson Creek, B.C.	Refinery	2,000 bbls.	$1,500,000	Under Constr.	End, 1955	.....	.....	.....
Hooker Chemicals, Ltd.	N. Vancouver, B. C.	Chemicals	.....	.....	Projected	.....	.....	.....	.....
Husky Oil & Refining, Ltd.	Moose Jaw, Sask.	Catformer, Desulfurization Unit, Vacuum Dist., Vis-Breaker, Crude Furnace	†5,000 bbls.	.....	Complete	.....	Atlantic, Husky	Fluor	Fluor
Husky Oil & Refining, Ltd.	Port William, Ont.	Expansion Catformer, Desulfurization Unit Asphalt Plt.	†5,000 bbls.	$1,000,000	Complete	.....	Atlantic	Fluor	Fluor
Husky Oil & Refining, Ltd.	Lloydminster, Alba.	Refinery Expan.	†8,500 bbls.	$1,000,000	Complete	.....	.....	.....	.....
*Imperial Oil	Sarnia	Expan. of Wax Facl.	.....	$4,500,000	.....	Late, 1956	.....	.....	.....
Imperial Oil	Sarnia, Ontario	Quality Control Lab. Packaging & Shipping Plt. and Mech. Shops	.....	$6,000,000	Under Constr.	1955	.....	.....	Canadian Bechtel

Construction Boxscore continued on page 215

Rockwood FogFOAM SpotPROTECTION System automatically drenches loading platform.

How to muzzle a vicious fire hazard

Dangerous, small-area fire hazards can viciously destroy life and nearby property — if not properly protected.

The tank truck loading platform above, for instance, imperils not only the tank trucks being loaded but also the storage tanks in back of it. Should a truck connection break during loading causing a static spark thus igniting a truck, millions of gallons of gasoline would go up in flames.

A Rockwood SpotPROTECTION FogFOAM System keeps this hazard muzzled — goes into action within 5 seconds of a fire's start. It cools entire area, blankets platform, controls fire, and protects surrounding area within minutes.

Each Rockwood SpotPROTECTION System is custom engineered to meet individual requirements of hazard. Systems handle WaterFOG, FogFOAM, FOAM or "WET". Three sizes: 2, 4 or 6 Heads. Operated automatically or manually. Automatic operations are for fixed temperature sprinkler type fire detectors or for heat actuated devices. Special Systems also available for use with Rockwood FOAM Maker Chambers.

Find out how these SpotPROTECTION Systems can meet your needs. Mail coupon below.

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Engineers Water . . . to Cut Fire Losses

Rockwood Foam, available in 5-gallon cans or 50-gallon drums, keeps Rockwood FOAM and Rockwood FogFOAM SpotPROTECTION Systems constantly replenished. No replacement problem.

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1082 Harlow Street
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*Title*_____
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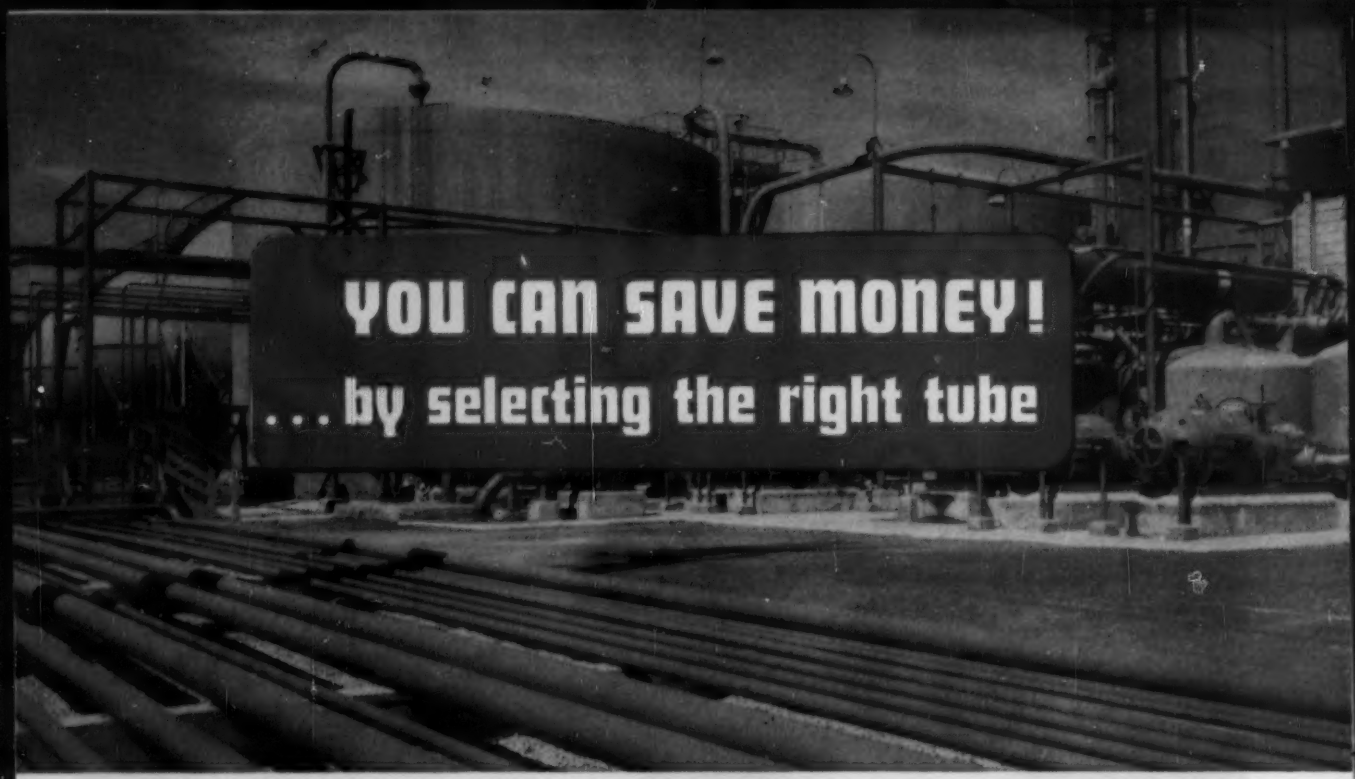
*City*_____
*Zone*_____ *State*_____



YOU CAN SAVE MONEY!
. . . by selecting the right tube

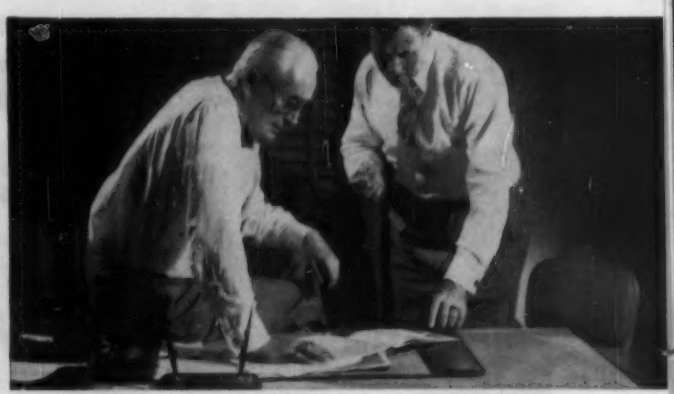
● The selection of refinery pipe and tubes presents many problems; basic differences in equipment, variations in fabricating operations, service pressure, high or low temperature conditions, presence of corrosive media, etc. Each of these factors must be considered in determining which pipe or tubing material is just right for a particular installation. Therefore, to insure you the best material at the lowest cost, the selection should be made by a tubing specialist.

Through research and laboratory experimentation, through on-the-scene observations, and by studying actual installations, National Tube refinery specialists have built up a collection of case histories that date back through 60 years of solving all types of tubing problems. The result of this extensive experience is the list of 25 different steel tube analyses shown here. Each analysis has been designed to combat specific refinery conditions, and each one has been tested and retested in actual refinery service. Other chemical compositions are also available in tubular products, and a wide variety of high temperature problems are now under study.

Examine the list of analyses. Then, before you make a decision as to which one you'll use, get in touch with us. Our engineers will help you select the analysis that will give you utmost efficiency coupled with the most economical performance. Write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

NATIONAL TUBE'S 25 DIFFERENT STEEL TUBE ANALYSES:

Carbon	2¼ Cr, 1 Mo	8 Cr, ½ Mo	18-8
Carbon, ½ Mo	2½ Cr, ½ Mo, ¾ Si	8 Cr, 1 Mo	18-8 Ti
½ Cr, ½ Mo	3 Cr, 1 Mo	9 Cr, 1 Mo	18-8 Cb
1 Cr, ½ Mo	5 Cr, ½ Mo	12 Cr	18-8 Mo
1¼ Cr, ½ Mo	5 Cr, ½ Mo, 1½ Si	12 Cr, Al	25-20
2 Cr, ½ Mo	7 Cr, ½ Mo	17 Cr	3½ Ni
	5 Ni		



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(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

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NATIONAL SEAMLESS PIPE AND TUBES

SEAMLESS WITHOUT WELDS

UNITED STATES STEEL

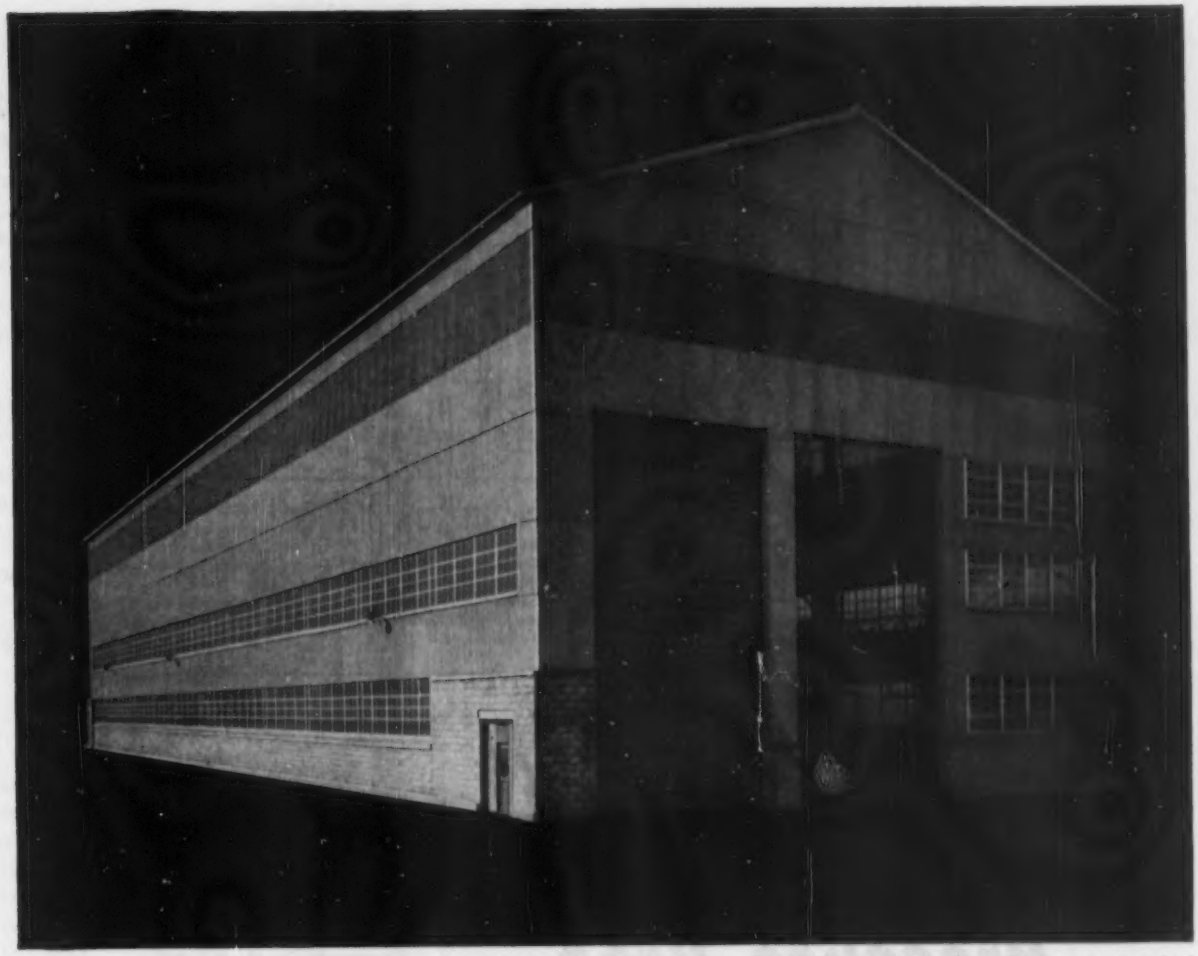
REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Imperial Oil, Ltd.	Edmonton, Alberta	Lube Oil Plt.	2,000 bbls.	$13,000,000	Completing	.....	.....	Staff & Can. Kellogg	Can. Kellogg
Imperial Oil, Ltd.	Imperoyal, Canada (near Halifax)	Rebuild Existing Plt. including Fluid Cat.	41,625 bbls.	$27,200,000	Under Constr.	Summer, 1956	.....	Staff & Can. Kellogg	Can. Kellogg
Imperial Oil, Ltd.	Ioco, B.C.	Naphtha Fractionator & Cat. Poly. Plt.	2,000 bbls.	$2,400,000	Under Constr.	Oct., 1955	.....	Staff & Can. Bechtel	Can. Bechtel
Inland Chemicals Canada, Ltd.	Fort Saskatchewan, Alta.	Sulfuric Acid Plt.	100 tons	$1,000,000	.....	.....	.....	.....	Lummus of Canada
International Waxes, Ltd.	Toronto	Contact Plt.	†140,000 lb.	$350,000	Planning	.....	.....	.....	.....
Kendall Refg. of Canada	Toronto, Canada	Cracker	27,000 bbls.	.....	.....	Summer, 1956	.....	.....	.....
		Lub. Oil Compounding, packaging & Distrib. Plt.	.....	.....	Considering	Indefinite	.....	.....	.....
McColl Frontenac Oil Co.	Edmonton, Alberta	Capacity Increase	11,000 bbls.		Complete	.....	.....	Staff	.....
McColl-Frontenac Oil Co.	Edmonton, Alberta	Thermal Cracking Unit	3,000 bbls.	$4,000,000	Complete	.....	.....	Can. Kellogg	Can. Kellogg
McColl-Frontenac	Montreal, East	Platformer	12,000 bbls.		Complete	.....	U.O.P.	Procon Can.	Procon Can.
Midland Pet. & Pacific Pet.	Stettler, Alta.	Crude Refinery	4,000 bbls.	$2,000,000	Under Constr.	.....	.....	.....	.....
North Star Oil, Ltd.	St. Boniface	Refinery	12,000 bbls.	$10,000,000	Under Constr.	July, 1955	U.O.P.	Can. Kellogg	Can. Kellogg
Northwest Nitro-Chemicals, Ltd.	Alberta	Nitrogen Plt.	.....	$20,000,000	Planning	End, 1956	.....	Commercial Solvents	Ford, Bacon & Davis
Polymer Corp., Ltd.	Sarnia, Ont.	Ethylene Plt. Expan.	.....	$2,000,000	Under Constr.	1956	.....	Staff	Staff
Polymer Corp., Ltd.	Sarnia, Ont.	Additional Turbo-generator—Steam and Power Plt.	.....	$500,000	Equipment	1956	.....	.....	Canadian General Electric
*Quebec Ammonia	Varennes, near Montreal	Synthetic Ammonia	120 tons	.....	Planning	.....	.....	.....	.....
		Refinery: Crude Unit, Thermal Cracker	2,000 bbls.	$2,000,000	Under Constr.	Nov., 1955	.....	Koch	Bohna-Lane
Royalite Oil Co.	Kamloops, B.C.	FluidCat.Crker., Poly & Gas Concentration	1,425 bbls.	$2,500,000	Complete	.....	U.O.P.	Caribou Eng. Co.	Caribou Eng. Co.
*Royalite Oil Co.	Coleville, Sask.	Vacuum Unit	3,800 bbls.	$170,000	Under Constr.	June 30, 1955	.....	Caribou Eng. Co., Ltd.	Company Construct.
*Shell Oil (Canada)	Montreal, East	Topping Expan.	11,000 bbls.	.....	Planned	Mid, 1956	.....	.....	.....
		Platformer	6,000 bbls.	.....	Planned	Mid, 1956	.....	.....	.....
		Hydrodesulfuriser	7,500 bbls.	.....	Planned	Mid, 1956	.....	.....	.....
		Increase Cat. Cracking	3,000 bbls.	.....	Under Constr.	End, 1955	.....	Shell	Shell
		Vacuum Flashing	12,700 bbls.	.....	Under Constr.	End, 1955	.....	McKee	McKee
		Offsite Facl.	.....	.....	Planned	Mid, 1956	.....	Fluor	Fluor
		Platformer	2,750 bbls.	.....	Under Constr.	.....	U.O.P.	.....	Procon
Shell Oil (Canada)	Shellburn B.C.	Platformer	3,300 bbls.	$1,500,000	Planning	Late, 1955	.....	.....	.....
Sherritt-Gordon Mines, Ltd.	Fort Saskatchewan, Alta.	Anhydrous Ammonia	75 tons	$34,000,000	Planned	.....	.....	.....	.....
Standard Oil (B.C.)	Vancouver	Refinery Expan.	†18,000 bbls.	$2,500,000	Under Constr.	Late, 1955	Standard (B.C.)	.....	Proconcan
Texaco Oil Co.	Edmonton, Canada	Gas Absorp. Plt.	.....	$6,000,000	Under Constr.	.....	.....	.....	.....
Wainwright Producers & Refiners	Edmonton,	Cap. Inc.	†2,300 bbls.	.....	Under Constr.	.....	.....	Troco	Troco
*X-L Refineries	Dawson Creek, B.C.	Houdriformer	.....	.....	.....	.....	.....	.....	.....
LATIN AMERICA									
Argentina									
Esso Refinadora Petroleo, S.A.	Argentina	Lubricating Oil Plt.	375,000 bbls. a year	.....	Planning (Unconfirmed)	.....	.....	.....	.....
*Fabrica Argentina	San Nicholas	Phenol Plt.	.....	$375,000	Planning Unconfirmed	Fall, 1956	.....	.....	.....
Yacimentos Petroliferos Fiscales (ENDE)	Cerro Bandera P. Huincul Neuquen	Dehydration Plt.	10,400 bbls.	.....	Under Constr.	1955	.....	Y.P.F.	Y.P.F.
Brasil									
Cia de Petroleo do Amazonia	Manaus	Refinery; Cat. Crker. & Aux. Units	5,000 bbls.	$4,500,000	Engineering	Late 1955	U.O.P.	Sweco	Sweco
Cia Brasiliera de Estireno	Cubatao	Styrene Monomer Plt.	.....	.....	Engineering	.....	Koppers, Firestone Polyco	Koppers	Koppers
*Petrobras	Mataripe, Bahia	Thermal Crker. Cat. Poly.	5,000 bbls.	$7,000,000	Complete	.....		Kellogg PA	Kellogg PA
		Lube Oil Cat. Crack. Expans.	†15,000 bbls.	$18,000,000	Planning	.....	.....	Kellogg PA	.....
*Petrobras	Cubatao, Sao Paulo	Thermal Crack., Naph. Reform. Visbreaking, Cat. Poly.	45,000 bbls.	$60,000,000	Complete	.....	Hydrocarbon, Calif. Res.	PA Hydro. Res.	PA Hydro.Res., McKee
		Other Expan.	†60,000 bbls.	$2,000,000	Complete	.....	Shell Div. Edeleanu	H.R.I.	Staff
		Asphalt Plt.	2,500 bbls.	$1,200,000	Under Constr.	Nov., 1955	.....	SWECO	SWECO
		Anhydrous Ammonia	100 tons	$8,000,000	Under Constr.	Early, 1956	Texaco Dev., Ammonia Cassle	Foster Wheeler	Foster Wheeler, Staff
		Nitric Acid	345 tons						
		Ammonian Nitrate	35 tons	$11,000,000	Under Constr.	Early, 1956	.....	Friedrich Uhde Uhde	Uhde, Staff
		Fertiliser	340 tons						
*Petrobras	North Brasil	Refinery	25,000 bbls.	.....	Studying	.....	.....	.....	.....
*Petrobras	South Brasil	Refinery	70,000 bbls.	.....	Studying	.....	.....	.....	.....
*Repedival	Rio de Janeiro	Refinery	10,000 bbls.	.....	Completing	.....	.....	KIC	KIC
Colombia									
Colombian Petro-Company	Barco Concession	Gas Treating Plt.	2,000 bbls.	$5,000,000	Under Constr.	.....	.....	.....	.....
International Petroleum (Columbia), Ltd.	Cartagena	Refinery	25,000 bbls.	$35,000,000	Planned	Late 1957	.....	.....	.....
Cuba									
*Refinadora Cubaigusa	Cabaigun, Cuba	Ref. Expan.	.....	.....	Planning	.....	.....	.....	.....
*The Texas Co.	Santia o	Refinery	20,000 bbls.	.....	Planning	.....	.....	.....	.....
*Shell	Cuba	Refinery	25,000 to 30,000 bbls.	.....	Planning	.....	.....	.....	.....

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Mexico									
*Cia Commercial Vacuum	Mexico, D.F.	Lube Oil Blending, Compounding	570 bbls.	$700,000	Planning	2nd Qtr., 1956	.....	.....	.....
Petroleos Mexicanos	Arbol Grande Tamaulipas	Improvements	.....	.....	Engineering	1955	.....	Staff	Staff
Petroleos Mexicanos	Ciudad Madero Tamaulipas	Enlarge,Modern-Feed prep. Cat. Crker. Fluid-cokker, Offsite	100,000 bbls.	$30,000,000	Planned	Early 1957	.....	.....	.....
Petroleos Mexicanos	Salamanca	Lubricant Plt.	12,500 bbls.	$15,000,000	Planning (Unconfirmed)	.....	.....	.....	.....
Petroleos Mexicanos	Reynosa	Absorption Plt.	300 Mmcf	$10,000,000	Under Constr.	2nd Qtr., 1955	.....	Hudson	Staff
Petroleos Mexicanos	Reynosa	Enlarge Topping Unit Thermal Cracking	5,000 bbls. 2,000 bbls.	.....	Engineering	Late 1955	U.O.P.	Staff	Staff
Petroleos Mexicanos	Salamanca	Lube Oil Fac., Wax Plt.	.....	$25,000,000	Complete	.....	.....	.....	.....
Petroleos Mexicanos	Poza Rica, Ver.	Expan. Gas Absorption purification, Water and Gas Repressuring	120 Mmcf	$20,000,000	Complete	.....	.....	McKee	Staff
Petroleos Mexicanos	Mata Redonda	Refinery Expan.	.....	.....	Planning (Unconfirmed)	.....	.....	.....	.....
Petroleos Mexicanos	Minatitlan	Topping, Feed Prep., TCC Cat. Crker., Poly, Offsite	25,000 bbls.	$12,000,000	Under Constr.	3rd Qtr., 1955	Socony, U.O.P.	Fluor	Staff
Petroleos Mexicanos	Mexico, D. F.	Cap. Increase	50,000 bbls.	$12,000,000	Under Constr.	3rd Qtr., 1955	.....	McKee	Staff
Petroleos Mexicanos	Pacific Coast	Refinery	30,000 bbls.	.....	Planned	.....	.....	.....	.....
Petroleos Mexicanos	Tampico	Refinery Expan.	.....	.....	Planning (Unconfirmed)	.....	.....	.....	.....
Netherlands Antilles									
N. V. Curacaosche Petro. Ind. Mij.	Curacao	Vacuum Still	20,000 bbls.	Part of $56,000,000 Project	.....	1956	.....	S & W. Badger Div.	.....
		Cat. Crker.	35,000 bbls.	.....	Planned	End, 1957	.....	.....	.....
		Catalytic Oil Gasification	.....	.....	Planning	.....	.....	H.W.P.	.....
Peru									
*Fertisa Limitada	Peru	Fertilizer Plt.	.....	.....	Planning	1956	.....	Montecatini	.....
Helios, S.A.	San Andres	Fertilizer Plt.	150,000 tons	.....	Planning	.....	.....	.....	.....
Helios, S.A.	San Andres	Lube Oil; Asphalt Refinery	60,000 tons lube oil; 10,000 tons Asphalt/yr.	$8,000,000	Projected	Early 1956	.....	Hydrocarbon	.....
Puerto Rico									
Americo Rodriques	San Juan	LPG Plt.	12,000 bbls.	.....	Under Constr.	.....	.....	Fluor	Fluor
Caribbean Refining	San Juan	Refinery	10,000 bbls.	$11,000,000	Under Constr.	.....	U.O.P.	Fluor	Fluor
Commonwealth Oil Refining Co.	Guayanilla Bay	Refinery:	25,000 bbls.	$25,000,000	Under Constr.	.....	.....	Lummus	Lummus
		Houdriflow Cat. Crker.	26,800 bbls.	.....	.....	.....	.....	.....	.....
		Houdriformer	3,730 bbls.	.....	.....	.....	.....	.....	.....
*Gonsales Chemical	Guanica,	Ammonia	115 ton	$12,250,000	Planning	.....	.....	Cox & Weinrich	Lummus
Venezuela									
Cia Shell de Venezuela	Cardon	Cat. Crker.	35,000 bbls.	Part of $56,000,000 Project	Planned	End, 1957	.....	.....	.....
*Cia Shell de Venezuela	Cardon	Catalytic Oil Gasification; Polymerisation; Treater, Feed Preparation	.....	.....	Planning	.....	.....	H.W.P.	.....
Creole Petroleum Corp.	Amuay	Fluid Hydro-former	10,000 bbls.	.....	Complete	.....	S.O.D.	S.O.D.	Foster Wheeler
Creole Pet. Corp.	Amuay Bay	Vac. Pipestill	42,000 bbls.	$7,000,000	Complete	.....	.....	Foster Wheeler	Foster Wheeler
Socony-Vacuum Oil Co. of Venezuela	Puerto Cabello	Refinery	.....	.....	Planned (Unconfirmed)	.....	.....	.....	.....
N.V. Bataafsche Petroleum Maatschappij	Cardon	Vacuum Still	66,000 bbls.	.....	.....	1956	.....	S & H Badger Div.	.....
Venezuelan Government	Puerto La Cruz	Petrochemical Plt.	.....	.....	Planning (Unconfirmed)	1956	.....	Montecarini	.....
*Venezuela Gulf Ref.	Puerto La Cruz	Cat. Reformer	8,000 bbls.	.....	Considering	.....	.....	.....	.....
EUROPE AND AFRICA									
Belgium									
Societe Industrielle Belge des Petroles	Antwerp	Cat. Crker.	10,000 bbls.	$10,000,000	Complete	.....	U.O.P.	Lummus	Lummus
*Petrochim	Antwerp	Ethylene Oxide, Ethylene Glycol	.....	$8,000,000	Engineering	.....	SD	SD	.....
Denmark									
A. P. Moeller	Copenhagen	Refinery	.....	$11,500,000	Planning	.....	.....	.....	.....
Egypt									
Egyptian Government	Alexandria	Refinery	.....	.....	Planning	.....	.....	.....	.....
Egyptian Government	Cairo	Refinery	20,000 bbls.	.....	Planning	.....	.....	Lummus	Lummus
Egyptian Government	Suez	Inc. Refn Cap.	26,000 bbls.	$24,000,000	Planning	.....	.....	.....	Lummus
England									
Berry Wiggins & Co., Ltd.	Weaste Ref., Manchester.	Extension to Refinery	500 bbls.	.....	Under Constr.	.....	.....	H.W.P.	H.W.P.
*British Petroleum	Kent	Oil Gasification	15 Mmcf	.....	Considering	.....	.....	.....	.....
Esso Petroleum Co.	Fawley	Refinery Expan. Including Hydroforming Unit	135,000 bbls.	.....	Under Constr.	.....	.....	.....	.....
*Hedon Chemicals	Greater Hill	Vinyl Acetate	.....	$2,500,000	Planning	.....	.....	.....	.....
Imperial Chemical Industries	Billingham,	Alcohols	140,000 tons/yr.	.....	Engineering	End, 1956	.....	Staff	.....
Imperial Chemical Industries	Wilton	Chemical Plt.	30 tons	.....	.....	1956	.....	S & W Badger Div.	E. B. Badger & Sons, Ltd.
Imperial Chemical Industries	Wilton	Terylene Plt.	22 mln. lbs./yr.	$50,000,000	Nearing Completion	1955/1956	.....	.....	.....
Imperial Chemical Industries	Wilton	Butadiene Separation Plt.	6/7000 ton/yr.	.....	Design	.....	.....	H.W.P.	.....
Imperial Chemical Industries	Wilton	Extension of Cracker	1250,000 tons/yr.	.....	Under Constr.	3rd Qtr., 1956	.....	Staff and Kellogg	KIC
Monsanto Chemicals	Britain	Add Polystyrene	.....	.....	Under Constr.	.....	.....	Staff	Staff
Monsanto Chemicals	Britain	Styrene-Butadiene Copolymer Plt.	4,000 tons/yr.	$14,000,000	Planned	.....	.....	.....	.....
Shell Refining & Marketing Co.	Stanlow	Hydrodesulfurisation	5,200 bbls.	.....	Under Constr.	Early 1955	.....	.....	.....

Construction Boxscore continued on page 219



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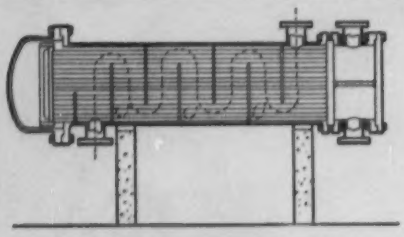
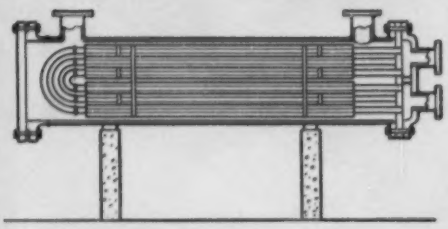
BROWN FINTUBE'S

BETTER DESIGN MEANS BETTER PERFORMANCE



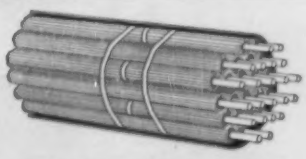
• Sectional View of Conventional Bare Tube Heat Exchanger Showing the Transverse Baffles that require the flow to make a series of 180° Bends, Resulting in Substantial Pressure Drop; Adding Unnecessarily to Pumping Costs; and producing Back Eddies, where Entrained Solids can Settle Out, Further Reducing the Heat Transfer Efficiency, and Increasing Cleaning and Maintenance Costs.



• Sectional View of Brown Fintube Bundle Exchanger. Fluid Flows through Hundreds of Long, Straight, Narrow Passages in Intimate Contact with the Heat Transfer Surface. The Only Pressure Drop Occurring Results from the Impingement of Flow Against the Heat Transfer Surface, and the Bends as the Fluid Enters and Leaves the Unit, Minimizing Pumping Costs, also Cleaning and Maintenance.

BROWN FINTUBE'S DESIGN ELIMINATES BAFFLES

Minimizing Pressure Drop



• View Showing the Banding of Alternate Fintubes to Prevent "Nesting", and Outer Bands that Produce a Tight, Compact Bundle of Long, Narrow, Straight Passages.

● The "bundle" in a Brown Fintube Exchanger consists of our integral "one-piece" fintubes connected with return bends; the other ends rolled into a tube sheet. A metal band strapped around each alternate fintube prevents "nesting", and the entire assembly is then banded tightly together.

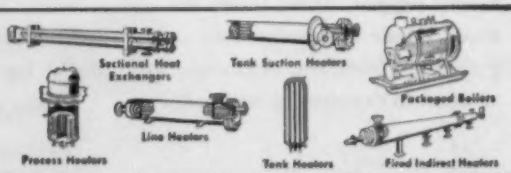
This construction produces hundreds of long, narrow, straight passages, through which the fluid flows. Carefully controlled velocities develop a turbulent flow, keeping heat transfer coefficients in a desirable range. There are no baffles, as when bare tubes are used, with their 180° bends to cause pressure drop, and create back eddies where entrained solids can settle out. In Brown Fintube exchangers, pressure drop results *only*, from the impingement of the fluid against the heat transfer surface, and the bends entering and leaving the unit.

The "one-piece" fintubes, available in carbon steel, alloy or non-ferrous metals, have 6 or 8 times more surface than plain bare tubing. They transfer more heat per lineal foot than plain bare tubing, saving space and weight;— and at lower temperatures per square foot of surface, preventing damage to heat sensitive materials.

Write for Bulletin No. 521. It lists dimensions and capacities of standard sizes. Other sizes and designs to meet any requirement. Write for your copy of Bulletin No. 521 ***today!***

BROWN FINTUBE CO.

370 HURON ST., *Elyria, Ohio*



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REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Shell Refining & Marketing Co.	Stanlow	Isopentane Plt.	.....	$1,400,000	Under Constr.	Early, 1955	.....	H.W.P.	.....
Shell Refining & Marketing Co.	Shell Haven	Cat. Reformer	6,700 bbls.	.....	Under Constr.	End, 1955	.....	.....	.....
Finland									
Nesteoy Corp.	Turku, Finland	Refinery	14,000 bbls.	$17,500,000	Planning	.....	.....	.....	.....
France									
Comp. de Raffinage	Petit Couronne	Cat. Crker.	8,000 bbls.	.....	Under Constr.	Mid 1956	.....	.....	.....
Shell Berre		Vacuum Still	33,000 bbls.	.....	.....	1955-56	.....	S & W Badger	.....
Comp. Francaise de Raffinage	Gonfreville	Refinery Expan.	.....	.....	Engineering	Mid, 1956	.....	Kellogg	KIC
Houilleres du Bassin du Nord et du Pas-de-Calais	Bully-Les-Mines	Ethane Cracking Plt.	20 tons	.....	.....	1955	.....	S & W Badger Div.	.....
Societe du Caoutchouc Butyl	Le Havre	Synthetic Rubber Plt.	20,000 tons/yr.	.....	Planning	.....	.....	.....	.....
Societe des Raffineries de Petrole de la Gironde	Ambes	Cat. Crker.	4,800 bbls.	.....	Engineering	1957	U.O.P.	U.O.P.	Lummus
		Vacuum Unit	6,300 bbls.	.....	Engineering	1956	.....	Lummus	Lummus
	Ambes	Poly Plt.	540 bbls. (Product)	.....	Engineering	1956	C.R.C.	Foster Wheeler	Lummus
West Germany									
Chemische Werke Huels, A.G.	West Germany	Synthetic Rubber Plt.	.....	.....	Considering	.....	.....	.....	.....
Badische Anilin & Soda Fabrik, A.G. & Deutsche Shell	Wesseling Area	Polyethylene & Ethylbenzene pH	.....	.....	Projected	1955	.....	.....	.....
Gewerkschaft Erdoel Raffinerien Emsland	Lingen	Houdriformer	3,500 bbls.	.....	Planning	End, 1955	Houdry	Lummus	Lummus
Kali Chemie Co.	Neinberg	Bead Catalyst Plt.	.....	.....	Licensed	.....	Soc.-Vac.	.....	.....
*Oelweke Julius Schindler	Hamburg	Lube Oil Ext. Unit.	900 bbls.	.....	Complete	.....	.....	.....	.....
Greece									
Greek Government	Piraeus	Refinery	30,000 bbls.	$15,000,000	Under Constr.	Jan., 1957	Atlantic	Hydrocarbon	Hydro. M, Krupp, Stahlunion, Stahlbau
Ireland									
*Erie Government Esso Petr. (Ireland) Caltex (Ireland) Irish Shell	Ireland	Refinery	.....	.....	Planning	.....	.....	.....	.....
Italy									
Ente Nazionale Idrocarburi	Ravenna	Butadiene Plt.	30,000 tons a yr. Rubber	75,000,000	Planning	.....	.....	Union Carbide Carbon;	.....
		Copolymer Plt.	350,000 tons a year, Nitrogen Fertilizers		Planning	.....	.....	Phillips Petroleum	.....
Azienda Generale Italiana Petroli	Venice	Platformer	1,750 bbls.	.....	Under Constr.	.....	.....	.....	.....
Azienda Generale Italiana Petroli	Cagliari	Refinery	500,000 tons	.....	Planning (Unconfirmed)	.....	.....	.....	.....
Golfo Industria Petrolifera S.P.A.	Gaeta, Italy	New Refinery	15,000 bbls.	.....	.....	.....	.....	Tecnider	.....
I.L.S.E.A.	Valmadrera, Como	Cat. Reforming Unit	500 bbls.	.....	Under Constr.	Spring, 1956	Atlantic	Tecnider	Tecnider
Industria Raffinazione Olii Minerali	Venice	Platformer	2,000 bbls.	.....	Under Constr.	1st. Qtr., 1956	U.O.P.	Procon	C.T.I.P.
Italia, S.P.A.	Cremona	Catformer	800 bbls.	.....	Under Constr.	July, 1955	Atlantic	Tecnider	Tecnider, Ansaldo
Montecatini	Barranca Bermeja	Anhydrous Ammonia Plt.	50 tons	.....	Planning (Unconfirmed)	.....	.....	.....	.....
Purfina Italiana,	Genoa	Platformer	1,000 bbls.	$550,000	Designing	Spring, 1956	U.O.P.	Staff	Staff
Purifina Italiana	Milan	Distillation Unit	15,000 bbls.	.....	Planning	.....	.....	.....	.....
Societa Per Azioni Raffineria Padana Olii Minerali (SARPOM)	San Martino di Trecate (Novara)	Cat. Crker.	2,880 bbls.	.....	Nearing Completion	.....	U.O.P.	U.O.P., E. B. Badger, Ltd.	S&W Badger Div.
		Vacuum Unit	5,150 bbls.	.....	Under Constr.	.....	.....	S&W Badger	S&W Badger Div.
		Poly. Plt.	315 bbls.	.....	Under Constr.	.....	C.R.C.	Foster Wheeler	S&W Badger Div.
Societa' Petrolifera Italiana S.P.I.	Fornovo Taro (Parma) Italy	Hydrotreating	1,000 bbls.	.....	Complete	.....	Staz. Sperimentale per i Combustibili Milano	Tecnider	Tecnider Staff
Socony-Vacuum Italiana, S.P.A.	Naples	Cat. Poly.	.....	$724,000	Complete	.....	Calif. Res.	Mediterranean Builders, Inc.	C.T.I.P.
Socony-Vacuum Italiana, S.P.A.	Naples	TCC	.....	.....	Complete	.....	Soc.-Vac.	Mediterranean Builders, Inc.	C.T.I.P.
Netherlands									
Caltex Petroleum	Pernis	Platformer	7,000 bbls.	.....	Engineering	1957	U.O.P.	Lummus, Ltd.	Lummus-Werkspoor
		Desulfurization	4,000 bbls.	.....	Engineering	1957	U.O.P., Union	Lummus, Ltd.	Lummus-Werkspoor
*Mekog	Velsen-Ymuiden	Nitrogen Fertiliser	.....	$9,000,000	Planning	.....	.....	.....	.....
Nederlandsche Dow Maatschappij N.V.	Rotterdam	Petrochemical Plt.	.....	.....	Planned	.....	.....	.....	.....
*N. V. de Bataafsche Petroleum Maatschappij	Pernis	Catalytic Oil Gasification	.....	.....	Planning	.....	.....	H.W.P.	.....
N. V. de Bataafsche Pet. Maatschappij	Pernis	Vacuum Still	66,000 bbls.	.....	Under Constr.	1955-56	.....	S&W Badger Div., E. B. Badger, Ltd.	.....
		Luboil Ref. Exp.	1,750 bbls.	.....	Complete	.....	.....	.....	.....
		Cat. Crker.	35,000 bbls.	.....	Under Constr.	Mid 1956	.....	.....	.....
Morocco									
*Societe Cherifienne des Petroles	Petitjean	Thermofor Cat. Crack.	160,000 tons/yr.	.....	Planning	.....	.....	.....	.....
Scotland									
British Petroleum Chemicals, Ltd.	Grangemouth	Alkylate Plt.	35 tons	.....	Planning (Unconfirmed)	1955	Calif. Research	S. W. Badger, Div.	E. B. Badger & Sons
Spain									
Instituto Nacional de Industria	Cartagena	Refinery Expan.	170,000 bbls.	.....	Planning (Unconfirmed)	.....	.....	.....	.....
Rafineria de Petroleos de Escombreras S.A.		Crude Unit	23,000 bbls.	.....	Engineering	1956	.....	Foter Wheeler	.....
		Platformer	8,000 bbls.	.....	Engineering	1956	.....	U.O.P., Foster Wheeler	.....
Sweden									
Johnson Line	Gothenburg	Refinery	2,500 bbls.	.....	Planned	.....	.....	Staff	Staff
Trieste									
S.P.A. Tecnico Industriale Aquila	Trieste	Cat. Cracking	3,200 bbls.	.....	Under Constr.	.....	Soc.-Vac.	Staff	Staff
		Cat. Poly.	1,400 bbls.	.....	Under Constr.	.....	U.O.P.	Staff	Staff

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Turkey									
*Turkish Government	Istanbul	Nat. Gaso. Plt.	.....	.....	Planning	.....	.....	.....	.....
Turkish Government	Kutahya	Nitrogen Plt.	.....	.....	Projected	.....	.....	.....	.....
Turkiye Petrolleri A.O.	Batman	Refinery	6,950 bbls.	$10,000,000	Under Constr.	Late, 1955	.....	Parsons	Parsons
Union of South Africa									
*Caltex (Africa)	Durban	Blending Lube Plt.	.....	$600,000	Under Constr.	1st Half 1956	.....	.....	.....
South Africa Coal & Oil & Gas	Coalbrook, Orange Free State	Plt. Expansion	3,500 bbls.	$50,400,000	Complete	.....	.....	Kellogg	Kellogg
Union Petrol Refinery, Ltd.	Johannesburg	Refinery	.....	$20,000,000	Projected	.....	.....	.....	.....
Wales									
National Oil Refineries, Ltd.	Llandarcy	Platformer	6,000 bbls.	$3,000,000	Complete	.....	U.O.P.	Procon (G.B.)	E. B. Badger, Ltd.
Yugoslavia									
Yugoslavia Government	Makarska	Refinery	.....	.....	Planning (Unconfirmed)	.....	.....	.....	.....
NEAR EAST									
Bahrain									
Bahrain Petroleum	Bahrain	Vacuum Still	23,000 bbls.	.....	Under Constr.	1955	.....	Lummus	Foster Wheeler
		Cat. Crker.	18,000 bbls.	.....	Engineering	1957	.....	Foster Wheeler	Foster Wheeler
		Poly Plt.	1,500 bbls.	.....	Engineering	1956	.....	Foster Wheeler	Foster Wheeler
		Vacuum Still	23,000 bbls.	.....	Under Constr.	1956	.....	Lummus	Foster Wheeler
Iraq									
*Iraq Government	Qaiyarah (Mosul)	Asphalt Plt.	2,000 bbls.	$3,500,000	Complete	.....	.....	Costain-John Brown	Lummus
*Iraq Government	Daura (Baghdad)	Refinery	24,000 bbls.	$28,000,000	Complete	.....	.....	.....	Kellogg
Jordan									
Jordanian Reconstruction Council	Mafrak	Refinery	.....	$7,500,000	Planned	.....	.....	.....	.....
Lebanon									
Mediterranean Refinery	Sidon	Refinery Expan. (Increase Crude Unit; Second Platformer)	†9,000 bbls.	.....	Under Constr.	End, 1955	U.O.P.	Bechtel Asso., Procon	Bechtel Asso.
Saudi Arabia									
Arabian American	Ras Tanura	Asphalt Plt.	1,250 bbls.	.....	Planning	1956	.....	.....	.....
Arabian American Oil Co.	Ras Tanura	Fluid Cat. Hydroformer	12,500 bbls.	$9,825,000	Under Constr.	Jan., 1956	M.O.D.	Lummus	Lummus
Saudi Arabian Government	Saudi Arabia	Ammonium Sulfate Plt.	400,000 Metric tons/yr. Plus 500 Tons Dry Ice	.....	Proposed	.....	.....	.....	.....
Syria									
*Syrian Government	Homs	Refinery	12,000 bbls.	$3,000,000	Considering	.....	.....	.....	.....
FAR EAST									
Burma									
Burma Oil Co.	Chauk	Distil. Unit	2,500 bbls.	.....	Under Constr.	.....	.....	.....	.....
Ceylon									
Ceylon Government & Shell of Ceylon	Hendala	Refinery	.....	$40,000,000	Negotiating	.....	.....	.....	.....
India									
Caltex Oil Refining (India) Ltd.	Visakhapatnam	Refinery	13,500 bbls.	.....	Under Constr.	1957	.....	Lummus Foster Wheeler Ewbank & Tardreas	Lummus
Indian Government	India	Synthetic Petroleum Plt.	6,000 bbls.	.....	Planning	.....	.....	.....	.....
Japan									
Daikyo Oil Co., Ltd.	Yokkaichi	Houdriflow & Cat. Poly.	3,500 bbls.	.....	Complete	.....	Houdry & Calif. Res.	Houdry	.....
Idemitsu Kosan Co.	Tokuyama	Refinery	18,000 bbls.	.....	Planning (Unconfirmed)	.....	.....	.....	.....
Mitsubishi Oil Co., Ltd.	Tokyo	Vac. Distl. Unit	2,000 bbls.	.....	.....	.....	.....	.....	..... **
Showa Oil Company	Tokuyama	Refining Fac.	.....	.....	Planning	.....	.....	.....	.....
Showa Oil Company	Tokuyama	Petrochemicals	.....	.....	Planning	.....	.....	.....	.....
Korea									
Korean Government	Korea	Urea Fertilizer Plt.	80,000 tons/yr.	$25,000,000	Planning	Mid-1957	.....	.....	.....
Sumatra									
Standard Vacuum Refinery	Palembang	Refinery Mod.	.....	.....	.....	.....	.....	Foster Wheeler	Foster Wheeler
Formosa									
Chinese Petroleum Corp.	Kaohsiung	Thermofor Cat. Crker.	10,000 bbls.	.....	Under Constr.	1956	Soc.-Vac.	Fluor	Fluor
		Cat. Reformer	3,100 bbls.	.....	Under Constr.	.....	Atlantic	Blaw-Knox	Blaw-Knox
Taiwan Fertilizer, Ltd.	Nankong	Ammonia Plt. to Produce Urea	260 tons	.....	Design Stage	1956	Vulcan	NH_3-Hydrocarbon Urea—Vulcan	Hydrocarbon
AUSTRALASIA									
Australia									
Australian Oil Refining, Ltd.	Kurnell	Refinery	22,000 bbls.	.....	Complete	.....	.....	S.A.W. Badger Div., E. B. Badger, Ltd., Ewbank & Partners, Christiani and Nielson, Foster Wheeler	E. B. Badger Pty.
Bitumen & Oil Refineries	Matraville, N.S.W.	Unifiner	.....	.....	Complete	.....	U.O.P.	Staff	Staff
		Platformer Expan.	†2,500	.....	Complete	.....	U.O.P.	Staff	Staff
British Petroleum Co.	Kwinana	Refinery	60,000 bbls.	.....	Complete	.....	.....	.....	Kellogg, Kellogg International, Costain-John Brown
Petroleum and Chemical Corp.	Silverwater	Petrochemical Plt.	.....	$7,000,000	Planned	Dec., 1955	.....	Power-Gas Corp. (Aust) Pty., Ltd.	Power-Gas Corp. (Aust) Pty., Ltd.
Socony-Vacuum	Altona	Alkylation Unit	1,700 bbls.	.....	Planned	Aug., 1956	.....	Kellogg	KIC
Standard-Vacuum	Melbourne	Refinery Expan.	25,000 bbls.	.....	Complete	.....	.....	Braun, Soc.-Vac.	Braun
Philippine Islands									
*Standard-Vacuum	Manila	Refinery	.....	.....	Unconfirmed	.....	.....	.....	.....
*Edgington Oil Ref.	Manila	Asphalt Plt.	.....	$3,000,000	Planning	.....	.....	.....	.....

* First appearance in tabulation † Added capacity

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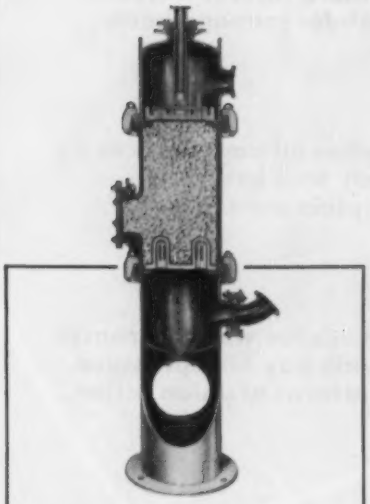
Quick facts about the services and equipment Pfaudler offers to help you reduce corrosion and processing cost.

Published by The Pfaudler Co., Rochester, N.Y.



Columns like this, heat exchangers, tanks, reactors and other equipment are available in glassed steel. Operating advantages include corrosion resistance, nonadherence, easy cleaning, no catalytic effect.

Your columns can pay their way faster, give extra years of service

Corrosion and rapidly changing process requirements sometimes make a column unusable or obsolete before it has had a chance to earn its keep.

One way you may be able to whip corrosion is by using the protection of Pfaudler's acid-alkali-resistant glass. It shrugs off attack by all acids except hydrofluoric, and alkaline solutions up to pH 12 at 212° F.

This glass is standard on Pfaudler glassed steel packed, or grid tray columns for fractionation, absorption, stripping, adsorption and extraction.

Because of its very wide range of corrosion resistance, Pfaudler glassed steel is also more flexible when you change processes – often saving you the cost of new equipment.

Standard Pfaudler glassed steel columns are rated for full vacuum and internal pressure starting at 25 psig. For higher pressures, special units can be custom built.

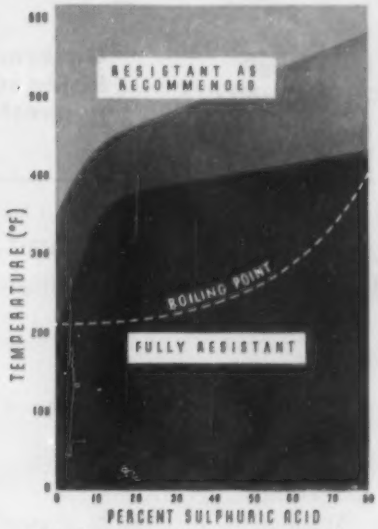
For *extra* corrosion resistance, and for process flexibility, ask your Pfaudler representative about glassed columns – or write for Bulletin 907.

NOW! Process H_2SO_4 in vessels *guaranteed* against corrosion!

Now you can have a year's free "vacation" from the expense of repairing or replacing equipment damaged by corrosion.

Pfaudler's exclusive one-year guarantee against corrosion is available on all acid-alkali-resistant glassed steel equipment for use with products on which field and laboratory data provide evidence of sufficient corrosion resistance. For example, a vessel for processing sulfuric acid 24 hours a day, 365 days a year can be guaranteed for a full year, and will actually deliver excellent service for as many as 15 years or more!

Similarly, many other corrosives can be covered by the same type of guarantee – and glassed steel equipment can actually give you 5 to 15 years more service beyond the guarantee period.



This chart shows the high resistance of glassed steel processing pure sulfuric acid 24 hours a day, 365 days a year. This type of laboratory data is basis for Pfaudler's unusual corrosion guarantee.

Under the terms of the Pfaudler corrosion guarantee, you receive free on-the-spot inspection and repair service on your acid-alkali-resistant glassed steel vessel, should it be made inoperable by corrosion within one year after date of purchase. Factory repairs will be performed on an F.O.B. factory basis. Operating conditions covered by the guarantee are agreed upon at time of purchase.

A wide range of corrosives may now be processed in Pfaudler corrosion-guaranteed equipment. Agreements are being written for any acid or alkali solution for which laboratory tests indicate sufficient corrosion resistance.

Right now, you may have an expensive corrosion problem that can be cured by this unusual guarantee on equipment. Write for further information.

Two Pfaudler heat exchangers in a distillation assembly.

Heat Exchanger Solves Cleaning, Gasket Problems

Pfaudler's Type FTS (fixed tube sheet) heat exchanger has won friends throughout the chemical processing industries. A money-saver, it features replaceable straight tubes, is easily cleanable on the inside and eliminates internal gasket leakage problems.

The shell is permanently welded to the tube sheets, doing away with gaskets or packed joints on shell side. There are no *internal* gaskets – no possibility of leakage or intermixture of fluids.

Original cost of Type FTS heat exchanger is low, because of its simple construction and standard design. Upkeep is low, because tubes are easy to clean, and you eliminate the problem of replacing costly internal gaskets.

For complete data on this cost-cutting "workhorse," write for Bulletin 837.

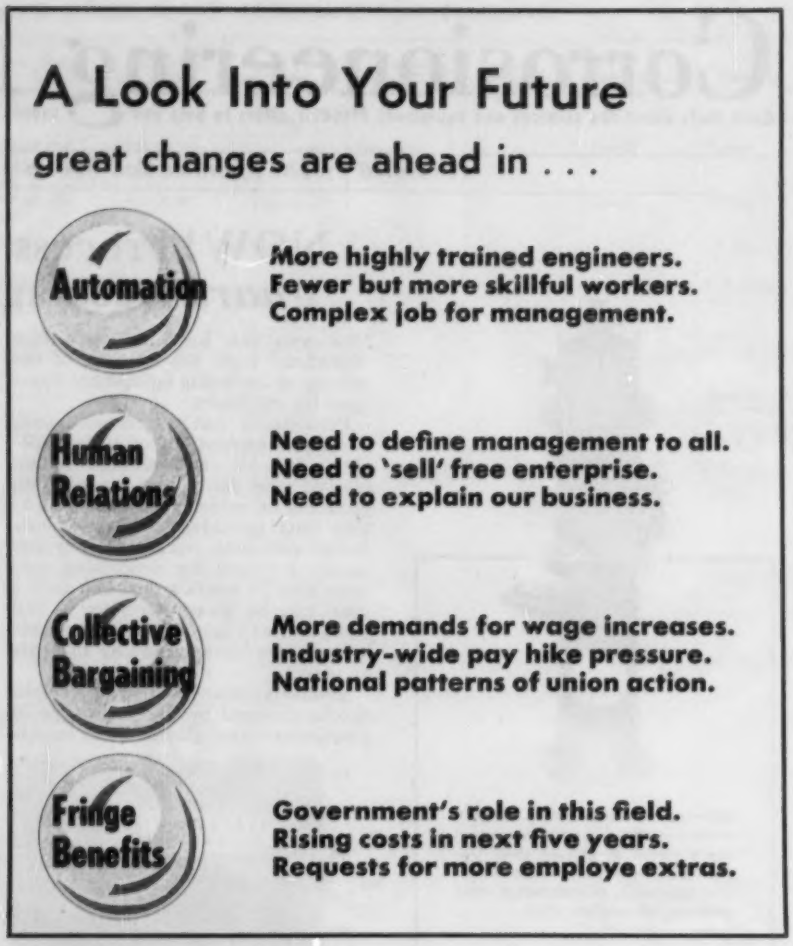
Got a chemical project that is bothering you?

We are staffed and ready to help you or your consultants in working out the best combination of materials and equipment to attain desired yields. Why not check with us?

For more data on advertised products, use Readers' Service Cards, last page.

As Management Sees It . . .

What's Ahead In Industrial Relations?


A Look Into Your Future
great changes are ahead in . . .
Automation
More highly trained engineers.
Fewer but more skillful workers.
Complex job for management.
Human Relations
Need to define management to all.
Need to 'sell' free enterprise.
Need to explain our business.
Collective Bargaining
More demands for wage increases.
Industry-wide pay hike pressure.
National patterns of union action.
Fringe Benefits
Government's role in this field.
Rising costs in next five years.
Requests for more employe extras.

The worker is now catered to by management, union and government. What more does he want? What will be the future trend in management-employe relations?

David F. Tver,
Anderson-Prichard Oil Corporation,
Oklahoma City

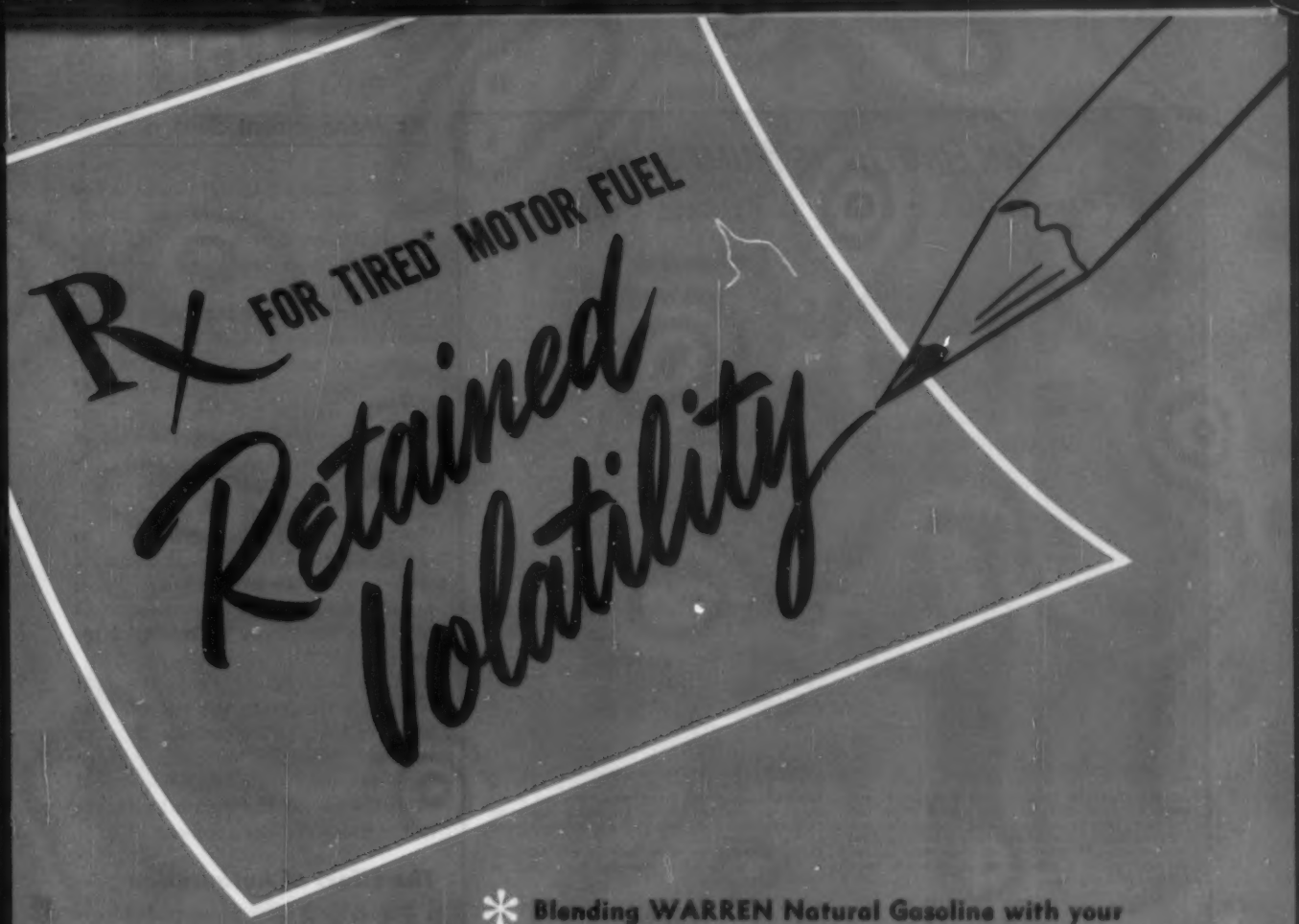
IN A RELATIVELY short span of years there has been a major transition in employe-employer relations.

From a sociological, psychological and economic view the worker has bettered himself. The worker now has many championing his cause. He is catered to by management, union and the government. He is better housed, better fed, better informed, better treated and has more economic and job security than ever before.

The government has entered into the fields of unemployment insurance, workmen's compensation, social security and labor relations. Management has provided many other benefits to insure the worker's welfare and security.

Much of this he takes for granted. He has received, and probably expects to receive, additional benefits in relation to health, retirement, and job security. He is looking for still more security. The "gimme" philosophy of socialism has cost industry the major portion of the bill.

What more does he want? What trend will the relations of management toward its employes take in the future? To understand what is ahead, it is necessary to look back. The great depression left an indelible mark. It fostered such a great fear of insecurity that it became a paramount drive of labor organizations and the federal government to guarantee the worker as much security as possible. Many of the present labor laws and social acts of the government began after this period. The demands of labor organizations increased the social and security benefits of the worker at a considerable pace in a relatively short space of years. The government passed legislation which created a favorable atmosphere for unionization and its accompanying demands. The pendulum swung from the Wagner Act to the Taft-Hartley, from no security to the present demands for guaranteed annual wage.



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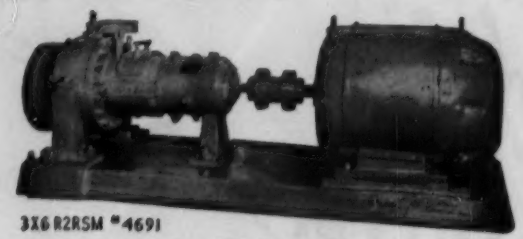
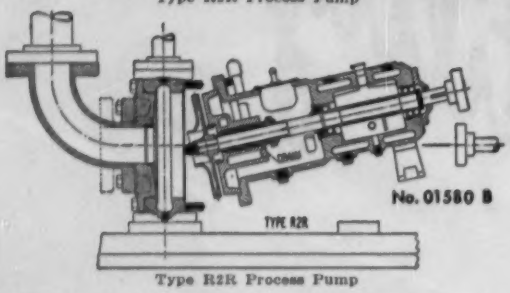
DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute. Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL and RECIPROCATING PUMPS

Close Coupled Centrifugal Pump.

3510
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids.

4043 AA
Pedestal Mounted Centrifugal Pump.

3833
Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump.

4728
Double Pedestal Bearing Centrifugal Pump.

3556
Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type.

ESTABLISHED 1869
DEAN BROTHERS PUMPS INC.
INDIANAPOLIS IND.
323 W TENTH ST.

Branch Offices: NEW YORK, N. Y., HOUSTON, TEXAS

Representatives in Principal Cities

As Management Sees It . . .

Before looking to the future, a few other questions should be asked. What is meant by security? Is there such a thing as guaranteed security? If the worker is guaranteed freedom from want, fear and unemployment, who guarantees the company he works for that it will continue to make a profit and stay in business?

Before we had the depression. Now we hear about inflation, the cost of living, collapse of the consumer market, "recession" instead of depression, and the green-eyed monster called "automation." So the worker tries to dig in a little deeper to hedge against these threats to his security. These are but some of the factors that will influence the future of industrial relations.

What lies ahead? From the past we can only judge the future. The areas relating to automation, human relations, collective bargaining, fringe benefits and communications will probably reveal the greatest changes in the industrial environment.

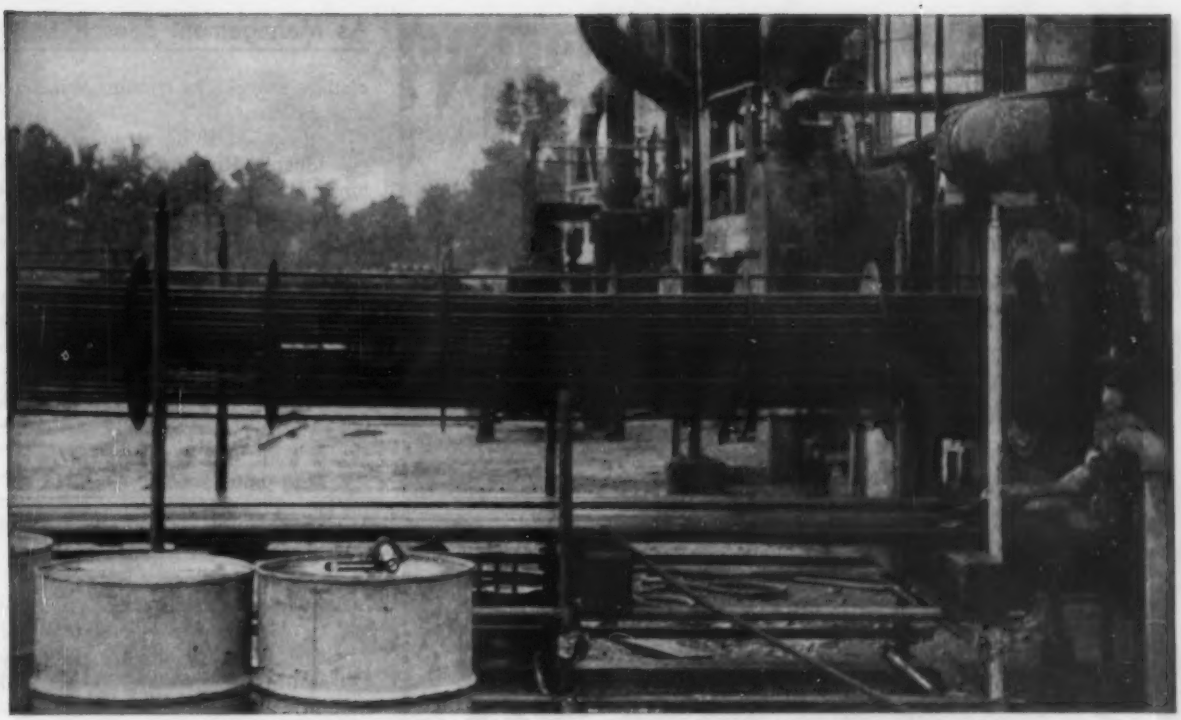
The Effect of Automation

There have been more technological changes and advances in our generation than in the whole epoch since man discovered the wheel. The continual increase in automation will have a decisive effect on industrial relations from many viewpoints in-

Meet the Author

DAVID F. TVER, who has contributed many fine articles to the Petroleum REFINER, holds both B. S. and M. S. degrees in clinical and industrial psychology and has supplemented his training with courses in industrial engineering. During the war, he served as a clinical psychologist and personnel consultant with the Medical Corps, and later did private consulting before joining Anderson-Prichard Oil Corporation some nine years ago as industrial relations director.

For more data on advertised products, use Readers' Service Cards, last page.



READY FOR INSPECTION—This bundle, which had been protected by Polyrad corrosion inhibitor, was pulled for inspection as part of the regular maintenance program.

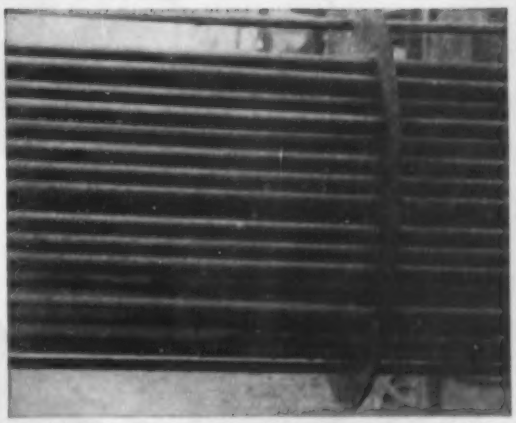
QUICK TURN-AROUND

Turn-around Time no longer need be headache time—not when Polyrad costs so little.

An average treatment is about 1 quart of Polyrad corrosion inhibitor per 1,000 barrels of fluid. That's all it takes to prevent excessive down time for cleaning or replacing fouled and corroded refinery equipment.

Polyrad's detergent action is so powerful that in many cases fouled equipment can be cleaned up while in operation. Organic and inorganic deposits don't have a chance to collect in Polyrad-protected equipment. They are quickly loosened and removed in the fluid stream. That's why all around the refinery, Polyrad helps maintain throughput, increases heat transfer, and cuts down time for maintenance.

Stocks of Polyrad are maintained throughout the country. A Hercules technical representative will be glad to discuss its application to your specific operating conditions.



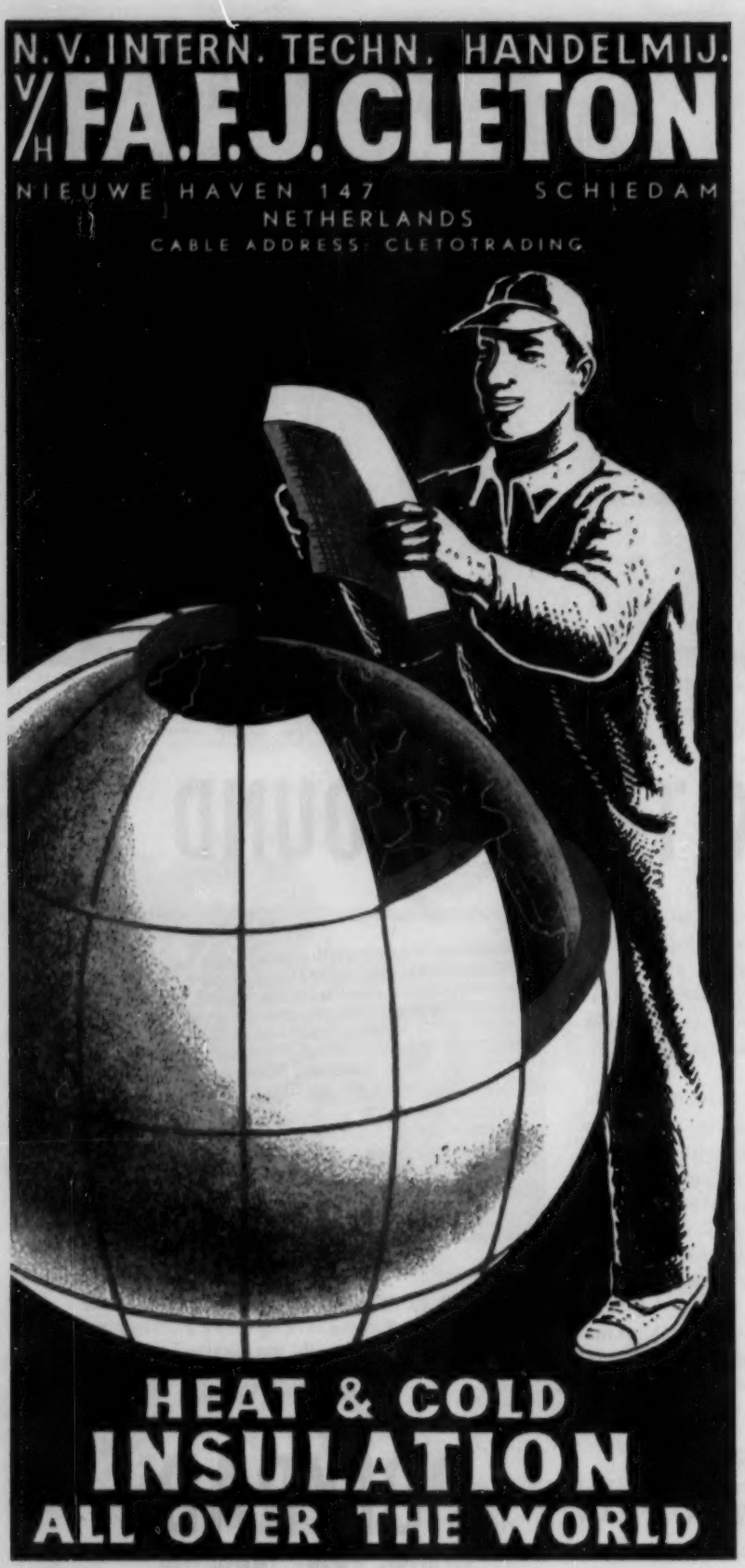
NO NEED TO REPLACE—Polyrad corrosion inhibitor had done its job well, as this close-up shows. Still clean and free of corrosion, the bundle was returned to service immediately.

Pine Chemicals Division,
Naval Stores Department
HERCULES POWDER COMPANY
INCORPORATED
976 Market Street, Wilmington 99, Del.

POLYRAD®
FILMING AMINE INHIBITOR

RA66-3

For more data on advertised products, use Readers' Service Cards, last page.



As Management Sees It . . .

cluding manpower, training and labor negotiations.

Automation is no stranger to the oil industry. Refineries have used automation as it is known today for years. However, the impact of automation in the future will probably be more felt in other manufacturing industries. While many plants employ more or less continuous processes with instrument control and mechanized materials handling, close surveillance is still required. In contrast, the fully automatic factory will probably consist of one or more continuous product lines, completely automatic, from raw material ingestion to finished product shipment, controlled and monitored by computers.

Complex Work Force—As automation increases the complexity of the work force will change. Industry will require more trained professional engineers, as more technical backgrounds will be required of personnel at all levels. There will be fewer but more highly skilled workers per unit of output and training will be longer and more costly. The changes will largely eliminate the repetitive tasks of machine operation and routine clerical work. Operators will be free for work requiring a larger proportion of creative ability.

The effect will also change the complexity of management. Increased skill will be required to run more technical organizations. With decreased need for inventory and the short change-over time on the factory floor and in the office, management will have to react quickly to changed market conditions. Rapid decisions based on high level judgment will be more necessary than ever.

Automation is also receiving its share of attention from labor organizations, and appears likely to be a topic of discussion in all future labor-management conferences. It has already been cited by Walter Reuther as the chief reason the CIO is demanding a guaranteed annual wage and short rather than long term contracts. The thinking of the unions is twofold: (1) the problems of machines replacing the present work force; and (2) the influx of increasing number of new workers into the labor market.

This might create the impression

For more data on advertised products, use Readers' Service Cards, last page.

It Costs No More to get the *dependable quality* that has made Solvay the world's largest producer of alkalies and associated chemicals.

Solvay Quality is the result of combining the nation's finest alkali manufacturing facilities with the experience gained in the 74 years that Solvay has been producing alkalies.

Fast, Efficient Delivery Service—Solvay's nation-wide chain of great manufacturing centers and over 200 strategically-located supply points are in a better position to make prompt deliveries—especially during your peak months.

Whether You're a Small or Large Refiner—you're always sure of receiving the close, personal attention that best fits your individual needs! Your specific requirements are handled by Solvay's trained and experienced local field representatives operating out of Solvay's 13 branch offices.

For Quality . . . Dependability . . . Service—make your first call Solvay by phoning or writing the Solvay office nearest your plant.

Soda Ash • Snowflake® Crystals • Potassium Carbonate • Calcium Chloride
Sodium Bicarbonate • Ammonium Bicarbonate • Cleaning Compounds
Caustic Potash • Sodium Nitrite • Caustic Soda • Ammonium Chloride
Monochlorobenzene • Para-dichlorobenzene • Ortho-dichlorobenzene
Chlorine • Chloroform • Carbon Tetrachloride • Methylene Chloride
Methyl Chloride

SOLVAY PROCESS DIVISION

Allied Chemical

ALLIED CHEMICAL & DYE CORPORATION
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PLANT SURVEY
Studies of your use of water or steam equipment and past performance.

WATER AVAILABILITY STUDY
Analysis of water supplies starting at source.

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Experienced chemists specialize in scientific water analyses and research.

DEVELOPMENT OF TREATMENT AND CONTROL SYSTEMS
Operational changes where necessary.

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Bird-Archer custom formulates chemical treatments for your specific problems.

EQUIPMENT RECOMMENDATIONS
Specification and furnishing of additional equipment when necessary, including complete analysis of savings and benefits made possible.

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Experienced technicians instruct your personnel in accurate control and test procedures.

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Personal call-backs to your plant by a Bird-Archer Service Engineer to assure best possible results.

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For Power For Process For Cooling

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BIRD-ARCHER COMPANY OF CALIFORNIA, San Francisco

that there are going to be serious employment problems ahead, but that is not necessarily true. To work upon this assumption, as many unions do, is to ignore the great ability of the American industry to grow and expand. Since we have what is perhaps the most dynamic and productive economy the world has ever known, our needs increase continually. As we satisfy our material needs for food, clothing and shelter we will develop other needs for travel, sports, leisure and other luxuries. Although there will always be cases of individual hardship, the whole society as a rule benefits; and through careful planning, retraining and individual help, the changes over the years will be relatively smooth.

Importance of Human Relations

All of these discoveries in electronics and chemicals may revolutionize methods, change living habits, disperse cities, and influence the social order, but man is still the measure of all progress. The years have not only changed methods and techniques, but our industrial concept of the individual. There has been an increasing awareness in management of the importance of the individual and the preservation of his identity as a skilled worker, supervisor or executive.

Any discussion of human relations must be concerned with the survival of industry itself as a free enterprise. Unless the worker understands the dynamics of business he will be led down the alley of socialism, too late to realize what a wonderful thing free enterprise is and how it made our nation great. Those in industry must enter into the fight for men's minds and hearts if we are to remain free of government control.

Defining Management—Capitalism and management should be discussed in such a way that it is readily understandable to all. Management should be defined to all employes so that they understand that managers in most cases are people who do not own the business, but are charged with the responsibility of getting results through the efforts of people—what we call human relations. We must spend more time in showing the worker that he has a job because of the stockholder who has invested his

Painting, courtesy Power Magazine

New J-M Color Code

identifies metal in Spirotallic® Gaskets

Most engineers know that Spirotallic Gaskets maintain a perfect seal despite extreme fluctuation in fluid pressure and flange compression. Consequently, these gaskets are used in a wide range of service conditions which include high temperatures, elevated pressures and active corrosives. To withstand these conditions, Spirotallic Gaskets employ a variety of corrosion-resistant alloys.

Because so many of these metals look alike, only expensive tests or costly experience with the gasket could determine the gasket metal used, once its identifying tag was lost. Now the color patch on the centering guide tells the metal employed and saves time, trouble and expense. This new method of identification also makes it easier for storekeepers and mechanics who handle the gasket. In addition, it simplifies inventories.

Spirotallic Gaskets hold their seal because they are made of spirally wound interlocking plies of asbestos and spring-like metal strip. These gaskets compress easily with light bolting. For catalog PK-35A and copy of color code card write Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ont.

Here are seven of the metals available and their color identifications

Zinc-coated steel—white

Type 304 Stainless—yellow

Type 316 Stainless—green

Type 347 Stainless—blue

Monel—orange

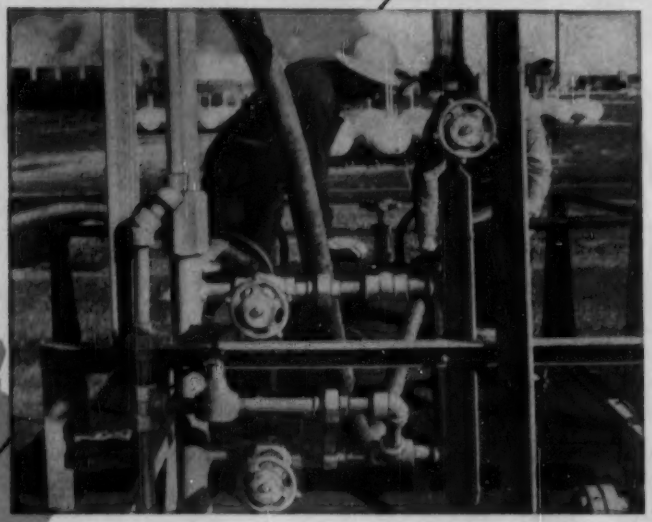
Copper—brown

Aluminum—aluminum

JOHNS MANVILLE JM PRODUCTS

Johns-Manville SPIROTALLIC GASKETS

WATSON-STILLMAN
FORGED STEEL FITTINGS



WORK BEST...under pressure

■ In high pressure steam lines... process liquid and gas piping... hydraulic fluid lines... wherever strong, tough pipe joints are needed, Watson Stillman Forged Steel Fittings provide a safety factor against costly piping failures. They resist pressure, heat, corrosion, shock and vibration because they're drop-forged of high quality steel to produce a dense, tough, forged-fiber structure that can really take it.

Extra strength is built into W-S fittings in other ways too... such as the heavy reinforcing bands extending well beyond the threads or sockets.

Protect your high pressure piping system with Watson-Stillman Forged Steel Fittings. Available in carbon, stainless and alloy steels, in Screw-End and Socket-Welding Types to meet your service requirements. Send today for Free Catalogs.

Bulletin A3-50—Forged Steel Fittings
Bulletin S-1-55—Stainless and Alloy Fittings
Bulletin U-1—Forged Steel Unions
Bulletin S-3-55—150 lb. Stainless Fittings

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WATSON-STILLMAN FITTINGS DIVISION

H. K. PORTER COMPANY, INC.
Roselle, New Jersey

13

As Management Sees It . . .

money and who should have a fair return for his investment. He should be shown that many of the stockholders of companies are from all walks of life like himself who have a few shares, who have invested their savings just as if they had put it in a bank.

He should understand that the manager of a business has a threefold responsibility; one, to the stockholder who expects a fair return for his investment; two, to the worker who is concerned about adequate wages and security; and three, to the consumer who wants a high quality product at a reasonable cost.

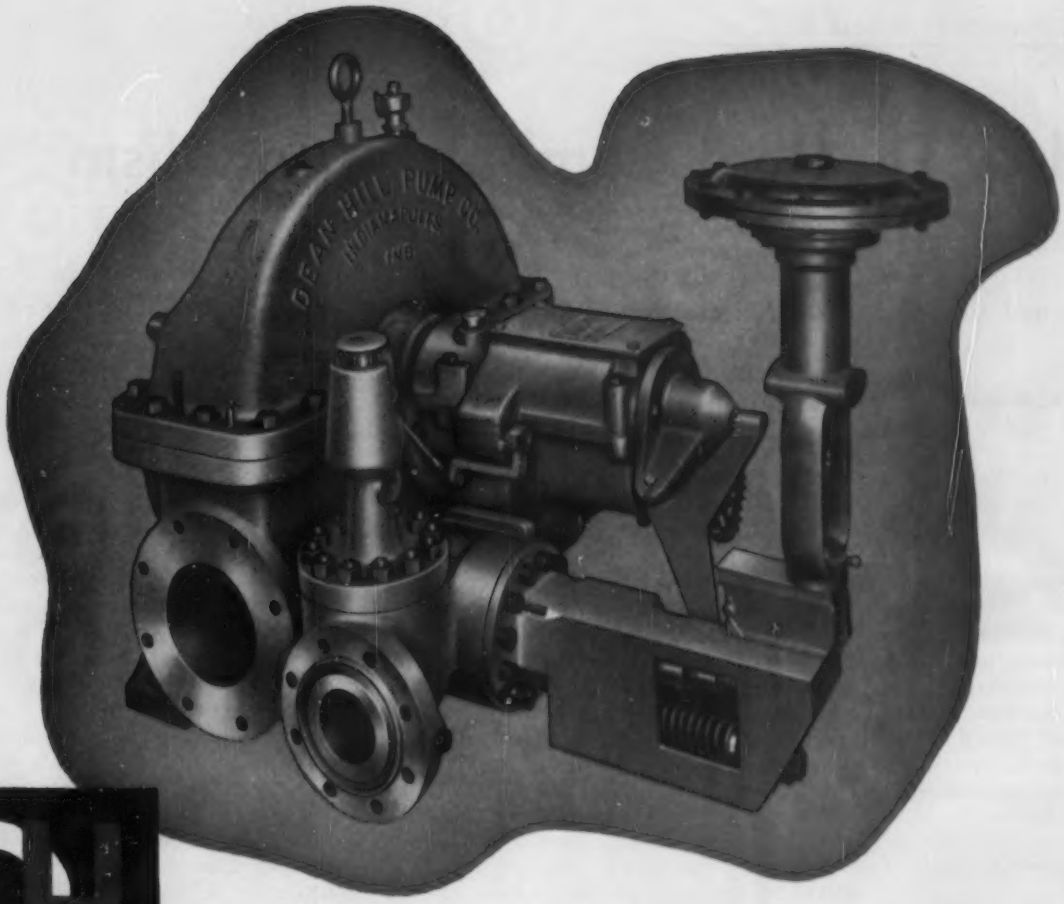
Do all employes know of these responsibilities? If so, do they believe them? It hasn't been too many years since many in management considered their sole responsibility to the stockholder. To accomplish the objectives of the triple responsibilities, it is necessary to develop people who understand business. Individual organizations must have sound objectives which are worth while, well known, and with a sound plan for carrying them out. The worker should be informed of them and his part in the successful accomplishment of the objectives. All this to be effective must depend on the ability and personal relationship of management men. We cannot solve this problem if we do not recognize that management has yet much to learn in the field of human relations, and that they cannot be solved if we do not recognize that one exists. And it should be recognized that management must be receptive and willing to listen.

We must recognize our need to keep on explaining our business to our people. An engineer can decide many things with a slide rule, but it is not the answer in human relations.

Collective Bargaining Wage Trends

Today industry is forced, more than at any other time, into a trend of industry-wide pattern increases. It is customary procedure for negotiators in manufacturing industries to find their bearings by taking sight on the one or two largest companies in the industry. Then, after an increase has been negotiated for the large

See INDUSTRIAL RELATIONS, Page 241



D-H turbines with pressure regulators solve constant fluid pressure problems

Dean Hill Turbines equipped with pressure regulators are "made to order" for boiler feedwater applications requiring precise, automatic pressure control. Regulators can be used with any turbine model of either horizontal or vertical design and are furnished with direct-acting or remote control. They can be arranged to maintain a constant pump discharge pressure or a constant differential pressure over the boiler pressure.

The regulator controls all turbine speeds up to normal rating, but above this point the turbine governor overrides the regulator to prevent overspeeding. The emergency trip valve remains independent.

To effect maximum efficiency of control and eliminate lost motion and deflection, the regulator is mounted on a rugged support made of welded six-inch channels.

For further information on D-H Turbines and optional accessories

write today for Catalog 500.

DEAN HILL PUMP COMPANY

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As Management Sees It . . .

How Du Pont Combats Alcoholism

Management recognition of the seriousness of this problem is the first step toward solving it. That accomplished, here is a plan which has been 65 percent effectual.

G. H. Gehrmann,
E. I. du Pont de Nemours & Company, Wilmington, Del.

"Every age has its problems, by solving which, humanity is helped forward."—H. HEINE.

THE ALCOHOLIC, or problem drinker, has too long been considered as a hopeless individual—weak-willed, psychotic, and in general beyond any aid that would lead to rehabilitation. He has been thrown out of industry, found himself unwelcome in general hospitals, spurned by family and friends, and allowed to shift for himself, eventually ending in skid row, a mental institution, or death.

Most industries throw him out without any attempt at rehabilitation; others waste time with threats and criticism. Too few try to understand the nature of his illness, or have any plans for a sound, sensible approach that can lead to rehabilitation.

Major Problem—Every chronic alcoholic, and often his family, is a potential burden for the taxpayers, which includes industry. It is estimated that 70 million people in this country drink alcoholic beverages, and that from 3 to 5 percent are chronic alcoholics. Thus, it should be obvious that chronic alcoholism is a major problem, one that not only warrants, but demands serious consideration.

Disease, according to our medical dictionaries, "is any deviation from the normal." Chronic alcoholism is a disease except for those who, by stretch of their imagination, consider the alcoholic a normal individual. The acceptance of alcoholism as a disease is one of the most important factors in any program of rehabilitation, more especially to the individual concerned.

During the past 40 years, the author has been associated with the DuPont Company. The protection and preservation of employes' health has been my assignment. This company has for many years realized the importance of good health, and has put much effort and money into a preventive health program. Alcoholism is one of the many phases of this program. The incidence has been no higher in DuPont than in any other group of employes, or the general public.

Up until the past 11 years, the methods of attempted rehabilitation followed the pattern of the then generally accepted methods: warnings, criticisms, sanatoria, and medical advice. The results were negligible, and, as a last resort, the employes were discharged. Sometimes they died of acute alcoholism even before discharge.

After observing the accomplishments of Alcoholics Anonymous, it was felt that here was a program that might produce better results. The then existing program results couldn't be worse, and from the angle of economics, the Alcoholics Anonymous program would be less expensive and might pay off in better dividends of employes rehabilitated. Our present plan has been successful beyond our expectations. It has been 65 percent effectual.

Any program designed to help the alcoholic must have the approval of top management, and it should be known by all the employes that the alcoholic need have no fear of losing his job, if he recognizes his disease, and takes the proper steps to overcome it. Further, every employe should understand that failure to try to help himself means discharge. There must be no exceptions to the penalty of willful failure, otherwise the plan will soon become ineffectual. Unfulfilled promises lend encouragement to further drinking.

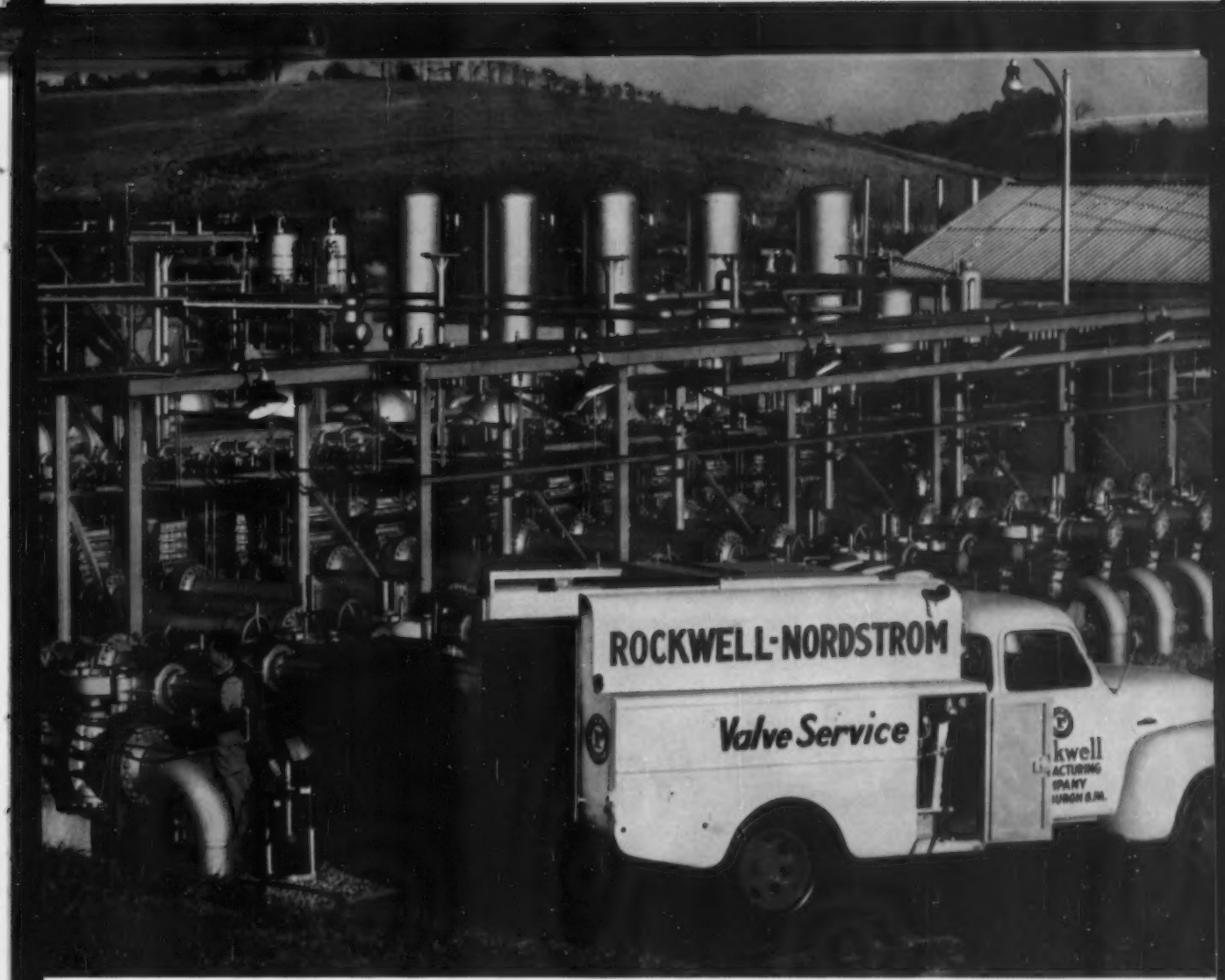
Four-Part Plan—Our plan consists essentially of 4 parts:

1. Educational lectures to management, supervision, foremen, and workers. These lectures are given by individuals who have learned about alcoholism the hard way—personal experience—and have been successful in overcoming their disease. They are rehabilitated alcoholics. One who has never been a problem drinker fails to make a lasting impression upon his audience. The alcoholic, on the other hand, sounds the voice of experience.

Our speaker usually startles his audience into immediate attention and interest by saying, "I am an alcoholic." He follows this bold statement with an account of his history of drinking and recovery. It is made perfectly clear that he is not delivering a temperance lecture, but rather alerting his audience to the modern con-

Meet the Author

G. H. GEHRMANN is due to retire this fall after 40 years as a physician with the Du Pont organization. Dr. Gehrmann joined Du Pont in 1915, following graduation from Long Island College, where he received his medical training and completed an internship in the college hospital. He saw service during World War I, returned to Du Pont in 1919 and was promoted to medical director in 1926. Last year, he became associate medical director in preparation for retirement in November, 1955.



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For forty years Rockwell-Nordstrom, the *original* lubricated plug valve, has built a reputation for valve economy. This year, Rockwell-Nordstrom users have even greater opportunities for valve economies through Rockwell's new mobile maintenance service, which is being made available on a contract basis.

Using the most up-to-date lubrication equipment on special Valve Lubrication Trucks, trained personnel will service all your Rockwell-Nordstrom valves on a schedule adapted to your individual requirements. These specialists will advise you on the correct Rockwell-Nordstrom lubricant for each of your services, and instruct your men on proper valve care that will allow further savings through greater efficiency and longer life.

Like Rockwell-Nordstrom valves themselves, this new Rockwell Contracted Maintenance Program has a single purpose: to give you the best valve service you've ever had, at the lowest cost per year. For complete information, write: Rockwell Manufacturing Company, Pittsburgh 8, Pa.

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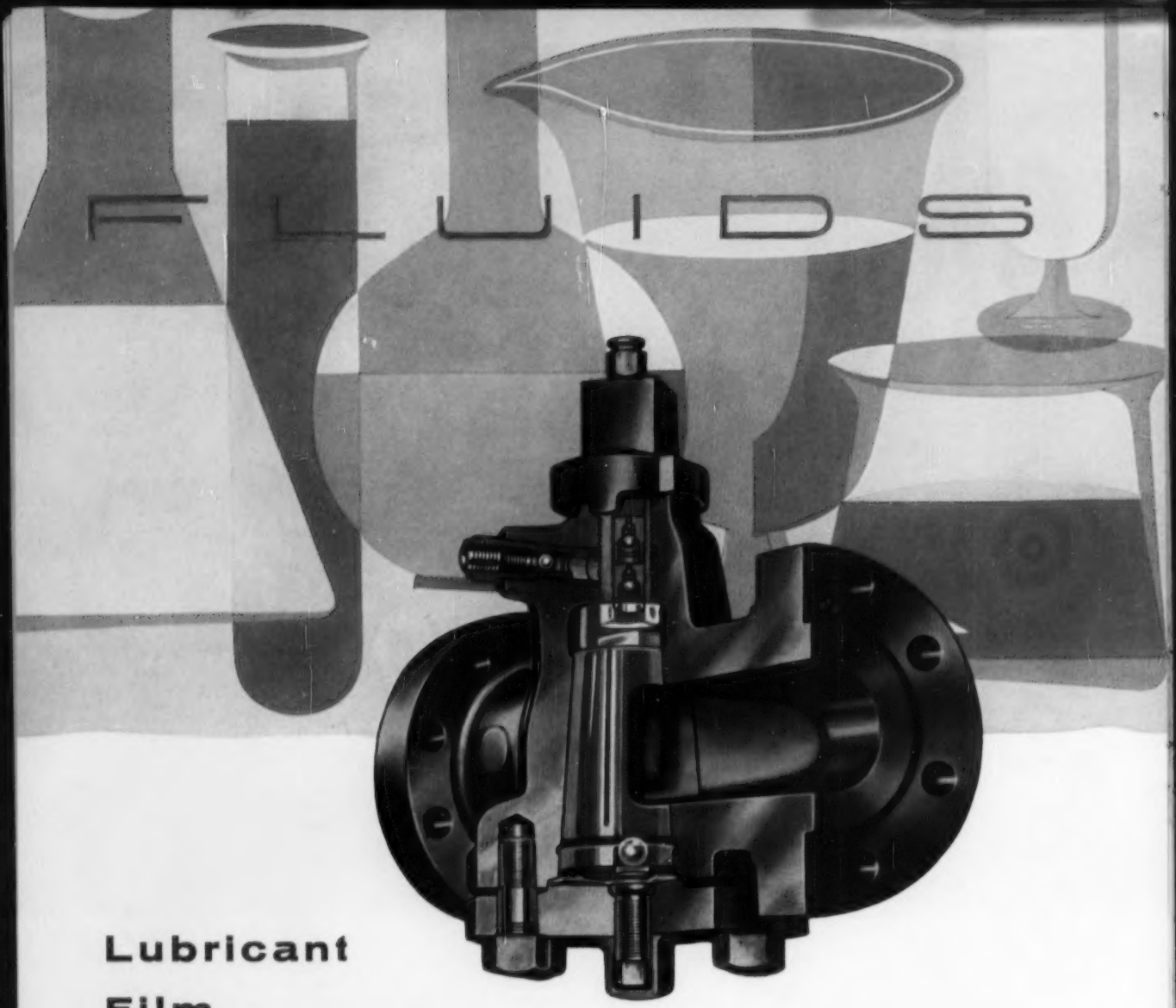

Lubricant Film Stops Metal-Hungry Fluids

Corrosive and erosive liquids are the nemesis of ordinary valves. But the thin, tough film of pressurized lubricant in Rockwell-Nordstrom valves forms an impregnable armor plating against them. And lubricant in the Sealdport* grooving provides a pressure seal that is dependably leak proof.

On liquid lines—or on any service—Rockwell-Nordstrom valves and lubricants will do a better job, longer, for less money. For complete information related to your valve problems, write: Rockwell Manufacturing Company, Pittsburgh 8, Pa.

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ROCKWELL-Nordstrom VALVES

LUBRICANT SEALED FOR POSITIVE SHUT-OFF

cepts of alcoholism, how one becomes an alcoholic, what help is available, and where to find it. He enumerates the early signs and symptoms of alcoholism, and emphasizes the importance of early recognition and treatment. Part of the lecture period is open for questions and answers.

An observing supervisor is in an excellent position for detecting most early cases of alcoholism. Some cases are extremely difficult to identify, principally the quiet or lone drinkers. However, there are certain signs and symptoms that serve to at least arouse his suspicion, such as: the bleary eyes, the trembling hands, the failure to maintain good personal hygiene and appearance, especially the individual who has heretofore been quite rigid in such matters. Negligence in shaving habits occurs, and his clothing is no longer neat and clean as formerly.

The most useful and positive information can be obtained from a study of the absentee record. Ordinary illness strikes on any day of the week. Absenteeism due to alcoholism most frequently starts on Monday. Thus, frequent absenteeisms which start on Monday are sufficient evidence to warrant careful investigation. A certificate of illness from the employe's attending physician can be misleading. Don't expect a physician to betray his patient by stating "John Doe has been under my care because of excessive drinking." Your plant physician should be able to clarify properly the accuracy of most health certificates.

Supervision need have no imaginary fears of getting into trouble by suggesting, in private conference, that an employe might be drinking too much over the week-end. In all of our years of experience this simple procedure has never resulted in trouble for anyone. It has clarified many problem cases and led to good results.

2. When a supervisor is satisfied that alcohol is a problem, the procedure is as follows: In a confidential interview he informs the employe that the time has come when the company can no longer tolerate his work performance, and unless he takes the necessary steps to overcome his disease, he will be discharged. The employe is put on a probationary period of three months, and immediately sent

the new mechanical seal for high temperature refinery pump service

The Sealol HT Mechanical Pump Seal ends costly and dangerous stuffing box leakage in high temperature refinery process pumps. This all-metal seal requires no external cooling circuit, yet it effectively seals hot bottoms, hot oil, and other higher viscosity products at temperatures up to 800°F. The HT Seal has been proved in actual refinery service. Being a cartridge type seal, the Sealol HT is ready to install . . . no loose parts to assemble — no special machining necessary. Shaft scoring is eliminated and pump maintenance reduced to a minimum.

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MOTORPUMP

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The fact that you get extra value for your money is evident the day you install Ingersoll-Rand Motorpumps in your plant. Installation is easy. No special foundation or aligning is needed. Their compactness saves space, too.

Moreover, their well-balanced impellers and precision machined parts help provide peak performance and smooth operation on every job.

Efficiency is assured by the advanced design of Motorpumps which obtains maximum volume and pressure when compared with the power consumed. They're available in sizes from ¼ to 75 hp . . . 5 to 2800 gpm . . . heads to 650 feet. Get our latest Motorpump catalog and find out why these are known as the "most dependable pumps you can install, start . . . and forget!"

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to the Medical division for further interview and medical supervision during the probationary period.

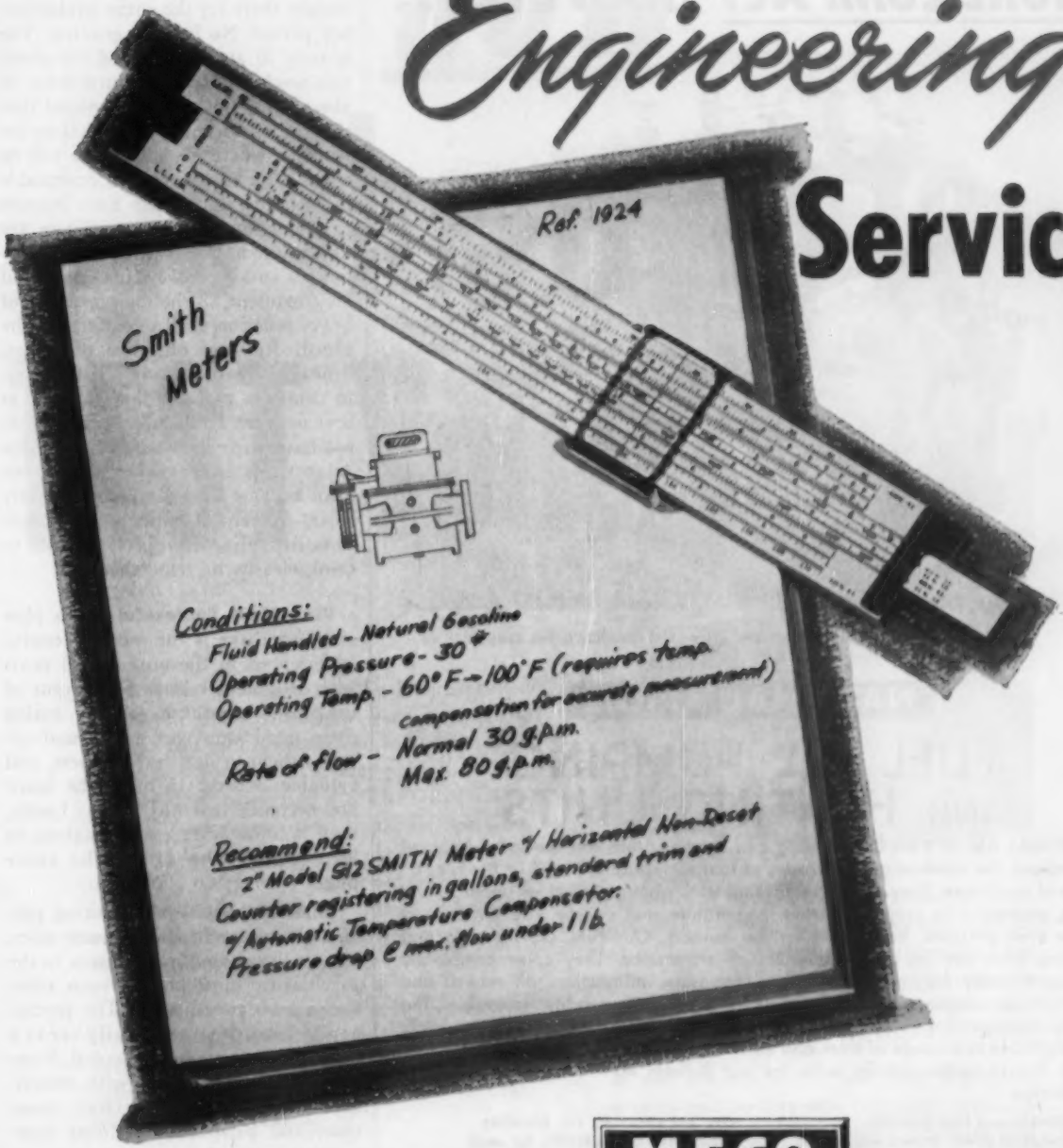
3. The medical interview is held in strict privacy and the approach is entirely sympathetic, never critical.

Alcoholism is explained as a diseased condition that will lead to total and permanent disability, or even death. Also, that it is a disease which cannot be cured; it can become arrested but the afflicted one can never drink again. If he does, drunkenness will soon be the result, despite any firm resolutions to drink socially and sensibly.

The patient is informed about the help he can get from Alcoholics Anonymous, but never told he must join. Anyone who joins Alcoholics Anonymous must do so of his own free will and desire. Those who are forced to join seldom derive any benefits from the association, and they usually resort to concealed drinking. Each afflicted individual must be impressed with the fact that his cure is entirely dependent upon himself. He must have a sincere desire to stop drinking, otherwise no one can help him. Every patient has it made perfectly clear that he has three months only, and during that time must prove to the satisfaction of Medical that he has recognized the seriousness of his situation and sincerely wants to get well as evidenced by positive action and results. Failure means, beyond a doubt, discharge; and it shall be so written into his personnel record and transmitted to anyone who in the future may be considering him for employment.

4. From Medical he is personally conducted for interview with one of our members of Alcoholics Anonymous. The purpose being to have him hear, first hand, from a person of experience, how sobriety has been attained through the help of Alcoholics Anonymous. He is then required to attend three Alcoholics Anonymous meetings, in order to see and hear firsthand, how many people have been helped and how. This completes our organized efforts to get him started and from then on he is entirely free to pursue whatever course he chooses, provided it leads to total and permanent sobriety.

Equipment with *Engineering* Service


Ref. 1924
Smith Meters
Conditions:
Fluid Handled - Natural Gasoline
Operating Pressure - 30 #
Operating Temp. - 60° F - 100° F (requires temp. compensation for accurate measurement)
Rate of flow - Normal 30 g.p.m.
Max. 80 g.p.m.
Recommend:
2" Model SI2 SMITH Meter w/ Horizontal Non-Recet
Counter registering in gallons, standard trim and
w/ Automatic Temperature Compensator.
Pressure drop @ max. flow under 1 lb.

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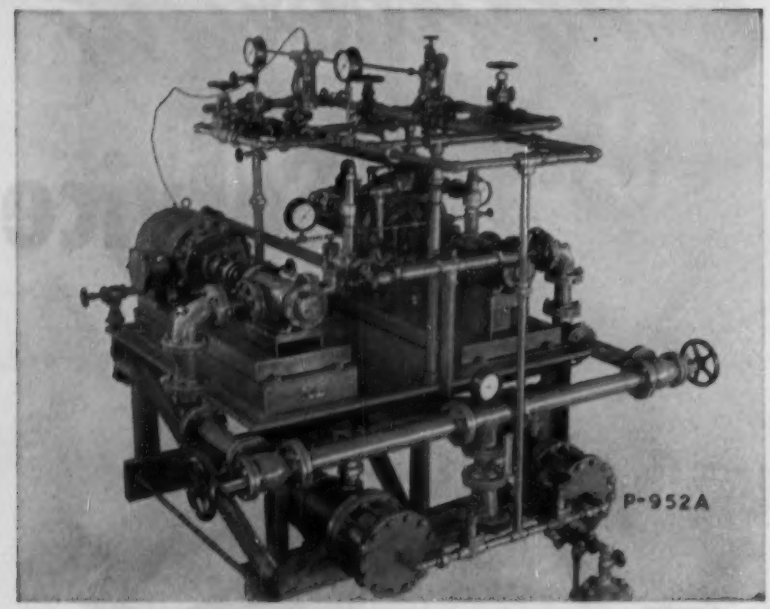
MORE COMPACT THAN EVER..



P-952A—Steam Turbine and Electric Motor drive gives flexibility in this compact Model P-ES2H size No. 25 unit.

NATIONAL AIROIL

FUEL OIL PUMPING *AND* HEATING UNITS

NATIONAL AIROIL Fuel Oil Pumping and Heating Units are specially designed to prepare, for combustion, all grades of fuel oil including No. 6 or Bunker "C" Oil and residuums. They will draw fuel oil from above ground or underground tanks, preheat it to proper constant temperature and deliver it to Oil Burners at an even pressure, best suited for the burners. Our Fuel Oil Pumping and Heating Units are the result of years of experience. They come completely equipped ready for steam, exhaust, condensate, oil suction, oil return, and electrical connections. All valves, regulators, etc., are readily accessible. The piping arrangement is easily understood. These compact, space-saving units are available in a range of sizes and models in both Medium and High Pressure types. For complete details, write for our Bulletin 40 — very interesting and informative.

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As Management Sees It . . .

Except for the very acutely ill, and those on the verge of delirium tremens, all must return to work and remain there for the entire probationary period. No leave is granted. The acutely ill are hospitalized for about two weeks, and are granted leave of absence for this period, provided that they agree to enter a hospital or institution where we know they will be treated by modern and acceptable methods, by those who have learned to understand alcoholism. There are too many hospitals where the alcoholic is still an unwelcome guest, and his treatment, in the main, consists of heavy sedation until the affects of the alcoholic wear off, then discharge, drunk with sedation, and instructions to drink no more or limit himself to beer or wine. Hospitalized patients do not have their medical and Alcoholic Anonymous interviews until they have become sober and are mentally clear. Acutely ill patients are unable to comprehend properly, unable to think clearly, or remember.

Plan Most Successful—This plan of procedure is the most successful experienced in the author's 40 years with DuPont. It leads 65 percent of the alcoholics back to sobriety, makes them good employes again, and restores them to health, happiness, and valuable citizens. In most, the home life becomes normal again. Lastly, they become willing and anxious to help others who are in the same plight.

Emotional problems requiring psychiatric treatment exist in some cases, but we never send our patients to the psychiatrist until he has been sober for at least two months. The psychiatrist cannot successfully treat a patient who, because of alcohol, is unable to think and talk with reasonable understanding. Further, many emotional problems become nonexistent with sobriety.

The cost of operating this plan is so nominal that it is hard to estimate. Our own medical staff handles the medical interview as part of their regular duties. The members of Alcoholics Anonymous never charge anyone for the help they give. The patient contributes only his efforts to rehabilitate himself, and continues to perform his daily duties during his period of treatment. Considering the

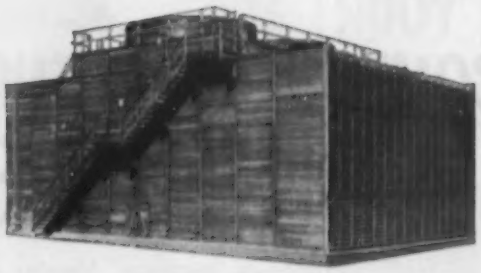
NOW

is the time to TEST Your Tower!

IF a water cooling tower has been installed in your plant in the past year, now is the time to find out whether the tower you own is the one you specified and paid for. This is the ideal time for a PERFORMANCE TEST. Your tower now should be operating at peak efficiency with all elements well coordinated. Of greater importance, ***this is the season when actual operating conditions most closely parallel conditions specified in your purchase contract.***

During summer months tower tests may be conducted at or near specified wet bulb temperatures, which means fewer variables, fewer calculations . . . it means the most accurate tests possible to obtain.

Since analysis of the results of a series of carefully conducted tests is the only method



of arriving at proof of the performance your tower is delivering, the manufacturer will be glad to assist in verifying the integrity of his product. He will welcome the opportunity to provide the necessary technical assistance that will enable you to conduct conclusive tests.

If you are not one of the 5000 engineers, operators and owners who requested copies of "Test Your Tower," the Marley brochure that explains a simple direct method of testing cooling towers, write for a copy today.

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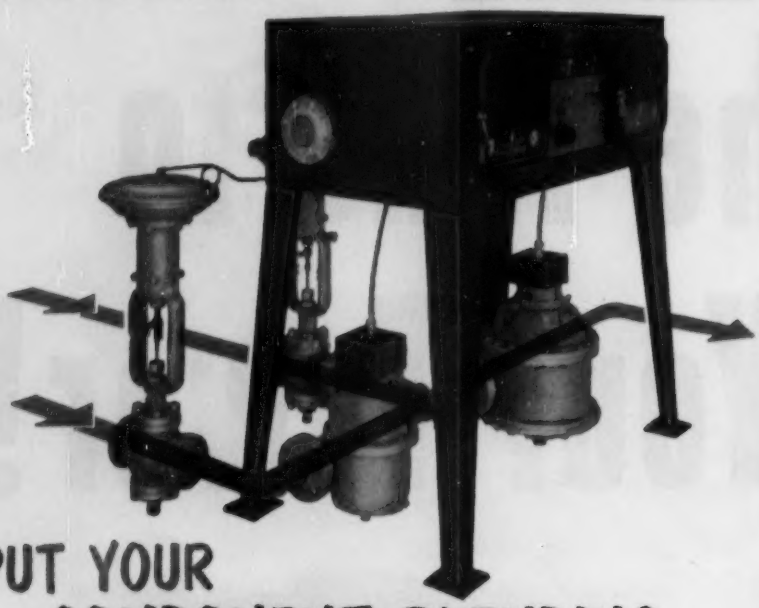
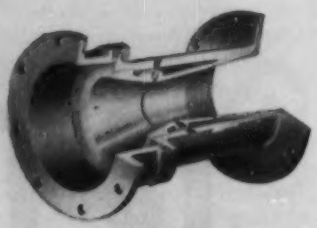
B-I-F METERS FEEDERS CONTROLS for the **PETROLEUM** industry



PUT YOUR COMPONENT BLENDING "ON STREAM"

This Proportioneers "package" blender puts component blending on a continuous and automatic basis. It is readily adaptable to the handling of both heavy and light components such as asphalts, bunker fuels, Diesel fuels, lube oils, gasolines, butane, propane, and solvents, required in the production of finished gasolines, fuel oils, heating oils, etc. Blend percentages are manually adjustable, and a "dry run" can be made to check the blend setting. Equipment includes positive interlocks for "fail-safe" operation.

Proportioneers stream blending systems — for two or more components — are now serving refineries in the United States and 16 foreign countries. Our experience in engineering, manufacturer and service of complete blending systems is at your disposal. Write Proportioneers, Inc., 412 Harris Ave., Providence 1, Rhode Island.



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B-I-F METERS FEEDERS CONTROLS

value of a human life, and adding to that the cost of training him to the point of usefulness, we save many thousands of dollars at comparatively infinitesimal cost. Consider also the savings in taxes that must be paid by industry, and all of us, in order to take care of those who go on to permanent disability, and leave, in many instances, dependents who require public support.

After varying periods of sobriety, some patients will begin to play with the idea that with the knowledge they have gained, plus the experience of the past, they can now return to controlled drinking. They start drinking again but soon go out of control. From this experience they become finally convinced that their only hope lies in total abstinence. These episodes are designated as "slips." It is expected that they will occur, from time to time. And it is known that these slips serve further as convincing evidence to the patient that he cannot be a controlled drinker. Allowances are made for two or three short slips, or relapses. ##

Industrial Relations

Continued from Page 230

company, the pattern is carried industry wide. This is not only true within the industry but in some cases it has an effect upon the allied industries.

For instance, the motor and steel unions always watch each other to see that either they are getting the same increase or can outdo the other. Statistically, there has been a very definite and consistent relationship between wage movements in steel and motor companies. The same trend has had resulting effect on other industries and in some cases has formed more or less of a national pattern. The pattern trend is also becoming more predominant in the oil industry.

It can safely be assumed that unions will continually ask for wage increases whenever and wherever possible. It can be assumed that these increases will be based upon any handy reason that can be thought of, such as cost of living, annual improvement factor, or for greater proportion of the corporate profit dollar.

The annual improvement factor is

View of Emsco Swivel Joints on one loading station.

Emsco 8" type LP Swivel Joint Style 2 with flanged ends for loading dock service.

EMSCO SWIVEL JOINTS SELECTED FOR NEW LOADING WHARF

We are proud to have supplied the Swivel Joints installed on this loading wharf making it one of America's newest and most modern loading facilities. Here are installed a score of Emsco 6" and 8" type LP Swivel Joints. Free turning and easy maintenance were prime factors in the selection of Emsco for this job. In the cross section note how the thrust load is absorbed through the ball bearings – how easily bearings can be adjusted. Note also how readily the packing can be replaced simply by separating the joint as one would a union. No return of joint to the factory for service. Emsco assures you a new kind of dependability in Swivel Joints.

Emsco's complete line includes Swivel Joints for high or low pressure, high vacuum, corrosive or high temperature service; for gas, liquid or semi-solids. Check with us or our field representatives. Over 500 various combinations to choose from. Sizes ⅜" to 12". Pressures to 15,000 lbs. Temperatures to 750° F.

Simplicity of Emsco's patented design assures a new kind of performance and dependability in Swivel Joint construction.

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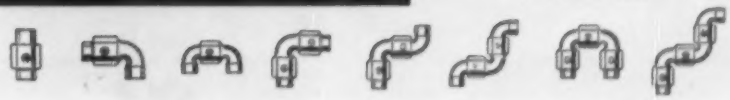

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how to be sure of your pressure vessel equipment

X-RAY INSPECTION OF WELD

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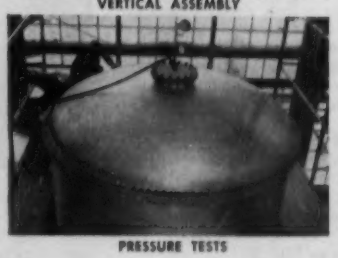

PRESSURE TESTS

If you are building a new chemical plant, changing a process, installing new equipment or renovating existing facilities, you want your process equipment designed, built and inspected in terms of your own special needs. Vulcan Manufacturing Division, by means of numerous specialized fabrication techniques (including those shown at left) and a thoroughly experienced process and mechanical design staff, can do that kind of job for you. This results from 53 years' experience in designing and building pressure vessel equipment for the chemical and process industries. Why not gain the advantages of this experience for your company? From either your performance or mechanical specifications, our design and fabrication people can assure you equipment that will meet the requirements of your particular operating conditions, process specifications and budget. Ask for estimates and design suggestions on your next project.

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a prime example. This factor has had indirectly a profound influence on wage movements during the past few years. One of the most important moving forces in the use of the annual improvement factor is General Motors. In essence, General Motors was anxious to have long term union contracts which could not be opened on any issue.

In order to get a long-term contract it was necessary to agree on some mechanical device to lean on, but both General Motors and the union recognized also that it was possible for employes in a prosperous and dynamic company to be able to look forward to progressive improvement in their real standard of living. The agreement on an annual improvement factor amount was a mechanism for achieving this end.

Neither the company nor the union claimed that the improvement factor was based upon increased productivity in the company or industry. Its rationale was based upon over-all annual average increases in productivity in manufacturing industries as a whole. There was nothing scientific about the amount selected to be given, nor was it based upon a statistical manifestation of an economic law. Yet many companies followed General Motors example blindly and used it without the slightest knowledge of what good it would do for the particular firm using it.

Trend Not Fixed—The industry-wide trend of collective bargaining is admittedly still not fixed. The unions have recognized certain economic conditions in particular industries and the nature of labor markets in certain areas, to negotiate lower than industry-wide average settlements. This will always be true to a certain extent because of the unions' realization that not to do so would mean economic disaster to its members in that area. However, as time goes on and unions solidify their strength, they will more and more tend to think in terms of joint action and national patterns.

Management is going to find itself increasing bargaining on standard rates, job classifications and job evaluations. It does not matter how precisely an engineer determines what a man can do on a given job. The main question is what a man will do in a plant where there is a strong union.

There will probably also be a

FLEXON METAL HOSE *Operating Briefs*

Vibration Stress on Fittings Relieved by Flexon Metal Hose

Pulsating pumps used to pump aviation gasoline were causing vibration that produced undue stress on fittings and lines leading to the pumps. The pumps are installed at an aviation gasoline bulk station where loose and ill fitting connections are a definite hazard.

Installation of 15" sections of 3" I.D. bronze Rex-Weld 91 Hose at the connections solved the problem completely. The flexible connections absorb all the vibration to rigid piping and fittings without loosening or undue wear.

If you have connection problems involving vibration, misalignment or expansion, call your Flexonics distributor today. He will supply the *right* Flexon Hose for your application to solve your problems.

FLEXON
The Complete Line for good connections

REX-WELD
corrugated metal hose is available in stainless steel, steel, bronze and alloys; sizes 3/16" through 24", I.D.; for burst pressures to 12000 psi.

REX-FLEX
corrugated stainless steel hose; sizes 3/16" through 6"; working pressures to 3100 psi.

REX-TUBE
interlocked, square locked and ball bearing type hose and tubing in steel, bronze, stainless steel and other alloys; sizes 3/16" through 12", I.D. for low and moderate pressures and for use as conduit, ducting, exhaust, protective armor, etc.

CATALOG No. 147
gives basic specifications and application data for Flexon Metal Hose. Write for your copy, today.

Flexonics *Corporation*
CHICAGO METAL HOSE DIVISION
1336 S. THIRD AVENUE • MAYWOOD, ILLINOIS
FORMERLY CHICAGO METAL HOSE CORPORATION

Flexon identifies products of Flexonics Corporation that have served industry for over 53 years.

Manufacturers of flexible metal hose and conduit, expansion joints, metallic bellows and assemblies of these components.
In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

THERE'S NO ROOM FOR VAPOR TO FORM IN A HAMMOND TUBESEAL FLOATING ROOF TANK

The Hammond Tubeseal Floating Roof is different from all other floating roofs because its design and construction does not provide space where air-vapor mixtures can form.

All floating roofs now in general use, except the *Hammond Tubeseal*, provide a space between the shell of the tank and the outer rim of the roof where air-vapor mixtures form.

If a sour crude is stored in a conventional floating roof tank, excessive corrosion of the tank shell and rim plates will occur where air-vapor mixtures form. Unless the metal shoes and flexible fabric covers provide an absolutely gas-tight housing, some of the vapor will be lost. If the stored product is of intermediate volatility such as jet fuel (JP-4 grade) combustible vapors will exist in this space under all normal atmospheric temperature ranges. Any ignition as from lightning will cause violent combustion.

The Hammond Tubeseal eliminates this space and prevents the forming of any air-vapor mixture. Corrosion is stopped even for sour crudes. Jet fuels such as JP-4 grade may be stored with assured safety from rim fires. *Vapors which cannot form cannot ignite or be lost.* There is no room where vapor can form in a Hammond Iron Works Tubeseal Floating Roof.

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HAMMOND TUBESEAL COSTS NO MORE IN THE FIRST PLACE

The most efficient and positive seal known.

no moving parts • no mechanical maintenance • overcomes tank out-of roundness • climate proof • non-corrodible • can operate to bottom of tank or above the top • no vapor space below the seal • entire circumference has tight seal under pressure at all times.

CHEAPER OVER THE YEARS

HAMMOND IRON WORKS
WARREN and BRISTOL, PA. • PROVO, UTAH
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greater concern on both sides with differentials between skilled and unskilled wage rates and with problems of equity between incentive work and day work. Here, then, are many of the problems between labor and management to be faced by management, none of which are particularly new to the industrial relations man, but should be thought about by the management engineer, the executive of tomorrow.

Question of Fringe Benefits

What are fringe benefits? There is no general agreement, but most managements accept four basic categories into which all of them fall:

- premiums for time worked.
- payments for time not worked.
- payments for employe benefits.
- payments for employe activities.

In legally required payments which only the employer pays, there are Old Age and Survivors Insurance, Unemployment Compensation Insurance, Workmen's Compensation, etc. In other agreed upon payments there are pension plans, life, sickness, hospitalization, surgical and medical care insurance, sick leave pay, jury witness, and voting pay allowances, wash-up time, vacation and holiday pay, state or national guard duty pay, time off for death in the family, etc.

Most employes accept these benefits. These "extras" which were formerly given at management's discretion are now increasingly a fixed part of the accepted employment structure and as such are regarded by workers, unions and government bodies as the subject of negotiations between labor and management on the same basis as issues of wages and hours. In many cases, they have been used as alternates in collective bargaining. But these benefits do not come cheap. There is a tendency to look upon them as something given away at no expense to the company. They are as much a part of the employe expense as salaries. The hourly wage rate is no longer a true indicator of the labor costs of operating a business. As more of these benefits are benefits are granted the spread between wage costs and labor costs widens.

Private industry paid out more than $7½ billion last year in supplements to wages and salaries. This totaled more than 5 cents for each dollar of all wage and salary pay-

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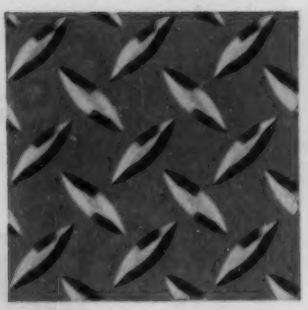

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You'll find 40 non-slip traction points, angle-engineered to safety, in every footstep of A.W. SUPER-DIAMOND, the lifetime-lasting rolled-steel floor plate.

Count the other points which make for combined economy and safety in this master flooring for entire floors or small areas—low cost, overnight installation, durability, easy cleaning, fast draining, resistance to fire, heat and most chemicals—and you'll find that every foot in your plant is safer when you install the exclusive-patterned

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Other products: A.W. ALGRIP Abrasive Rolled Steel Floor Plate—Plates—Sheets—Strip—(Alloy and Special Grades)

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As Management Sees It . . .

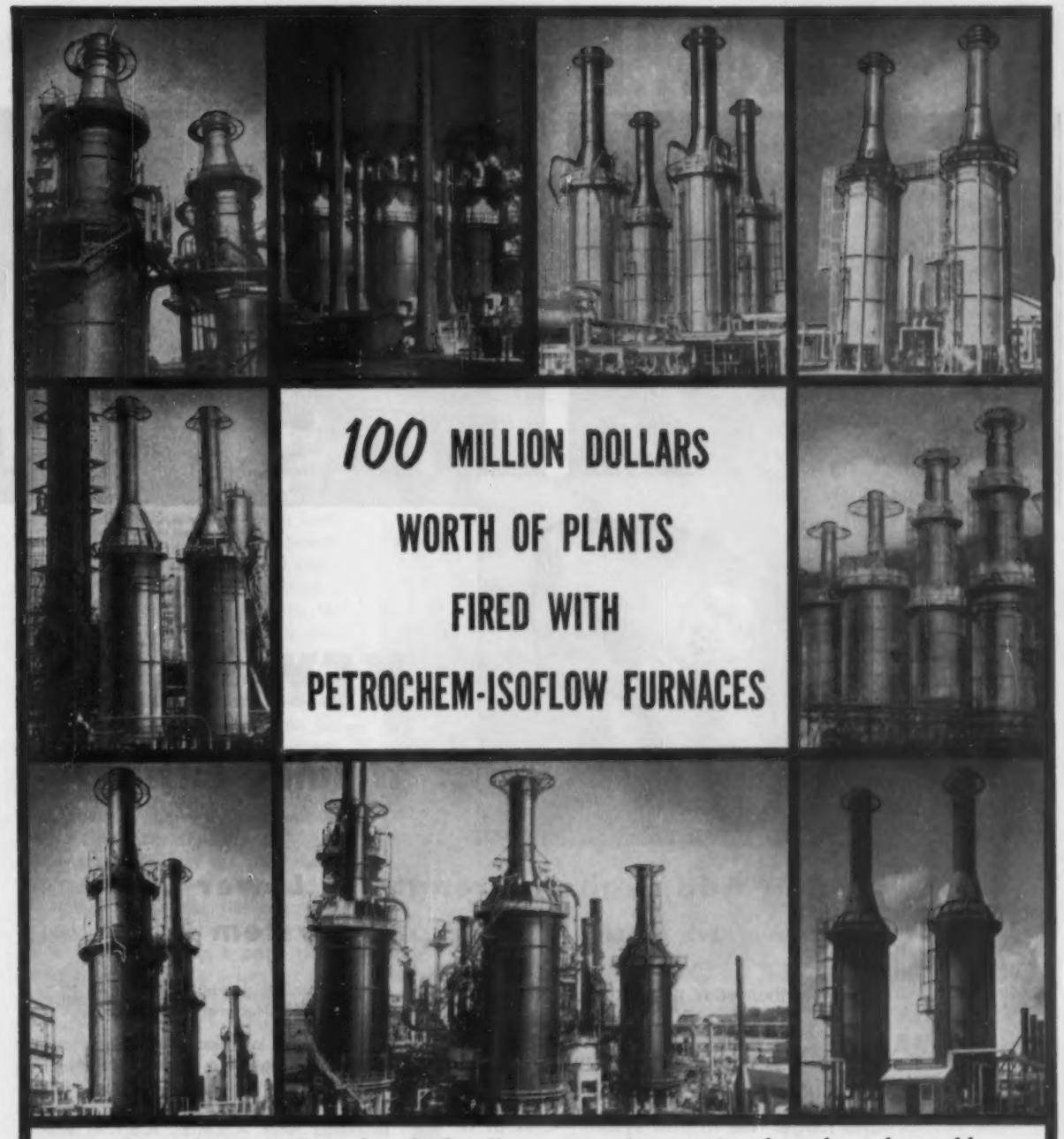
ments by private industry. In order to get a factual picture of non-wage labor costs of doing business, the U. S. Chamber of Commerce conducted a series of surveys on fringe benefits in which 529 firms participated across the nation. Fringe payments for 1953 averaged 19.7 percent of payroll. Manufacturing firms averaged 16.9 percent of payroll for fringe benefits with petroleum refining paying 22.7 percent and chemicals and allied products 22.6 percent.

Expressed as cents per payroll hour, fringe payments were 35.6 cents for all companies; 31.8 for manufacturing firms; and 41.3 cents for non-manufacturing firms. Expressed as dollars per year, per employe, fringe payments were $739 for all companies, $674 for manufacturing firms, and $841 for non-manufacturing firms. Altogether, the Chamber's study showed that fringe payments for 317 identical companies increased from 18.3 percent of payroll in 1951 to 19.5 percent in 1953 and the percentage is still going up.

One of the foremost changes in group benefits will probably come in the form of improved pension programs. As many of the larger companies make their pension plans more generous, it will undoubtedly confront many smaller employers with substantial and expensive equalization proposals.

Industry will also probably be confronted with requests for larger sickness and accident payments, higher daily hospitalization allowances, increased allowances for miscellaneous hospital charges, and higher surgical schedules. This is also in line with present employe resistance to enforced waiting periods prior to indemnity payments for time lost due to sickness or accidents. The trend appears more noticeable in large cities where unions have united in establishing cooperative medical clinics for union members to receive free medical care. The cost of the clinic is borne by the companies of the employes who, in most cases, contribute the entire amount for the employe.

Cost to Increase—On the whole, it is clearly recognized the cost of fringe benefits will increase over the next five years, especially in areas such as group insurance, pensions and



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More than 1250 Petrochem-Isoflow Furnaces are in operation throughout the world in the petroleum, chemical and allied industries . . . for all processes and for any duty, pressure, temperature and efficiency . . . and all Petrochem-Isoflow Furnaces are most efficient by any comparison.

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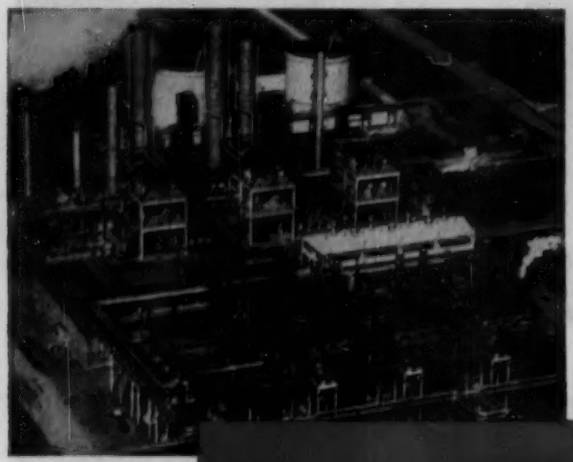
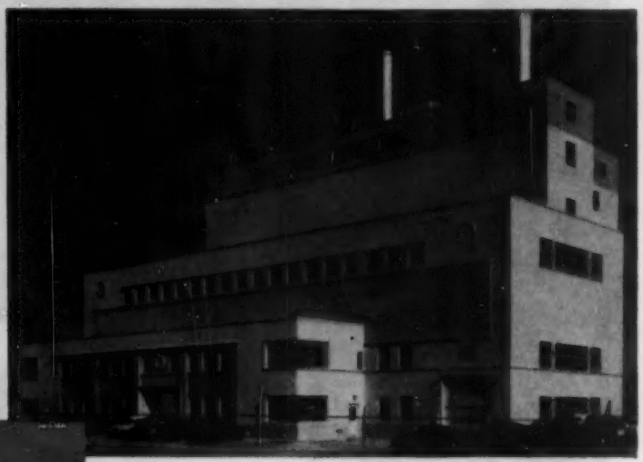


Sun Oil Company petrochemical plant, Marcus Hook Pennsylvania



Power plant, Colorado Springs Department of Public Utilities

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Can Add Higher Strength at Lower Cost to Your Alloy Piping System

Whether your product is petrochemicals . . . power . . . or anything else requiring an alloy piping system, an investment in Key-Kast fittings can add higher strength and longer life to that system—and at a real economy, too. Here's why:

- Greater wall thickness throughout—for increased structural strength
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- Materials meet A.S.M.E., A.S.T.M. and A.S.A. Codes
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vacations. If they continue to be given as they have been, it is reasonable to expect that another 40 cents an hour will be added to such costs in the next five to ten years.

The question that arises is not one of giving. Industry has demonstrated its willingness to improve working conditions and the workers' over-all social and economic status. The question appears to be, "What shall be given the emloye by the company to improve or benefit his working conditions, consistent with a company's ability to pay? This question is important not only to management but to the worker himself.

Does an additional guaranteed holiday benefit the worker more than increased pension benefits? Do increased shift differentials mean more than better hospitalization benefit provisions? Of what value will many of these "fringe benefits" be when a refinery is forced to shut down because of its inability to compete economically?

The U. S. has been through a sustained period of prosperity. Because of a primed economy it has been difficult to visualize a highly competitive market. This competitive market has now arrived with resulting reduction in profit, increased competition, and reduced operations.

It is relatively easy for an engineer to prepare a cost analysis on a piece of refinery equipment and determine its payout in terms of increased quality or productivity. It is only speculation to determine whether the granting of increased shift differentials or an additional holiday will increase worker productivity. Yet the problem is relatively the same. There should be a return in some form for the money spent, whether tangible or intangible.

An engineer, to be successful, must not only be aware of the mechanical and technical cost and operation, but also of the human element. When we speak of employe benefits, we are speaking of a human factor that is also covertible in terms of dollars and cents as a cost of doing business. It is the sum total of all the costs that determines the unit price.

Industry has granted many benefits in the past 50 years. It is no longer a question of basic security, but of obtaining refinements. It is hoped that the ability of industry to absorb

To combat contamination . . .

UNION OIL USES HAMER

Main pump house manifold at Union Oil's Wilmington refinery uses hundreds of Hamer Line Blind Valves.

HAMER *Visible Shut-off* LINE BLIND VALVES

HAMER Plug Valves

Custom-crafted, Hamer Plugs welcome the tough applications where ordinary plug valves fall short. Standard dimensions. Readily installed.

With literally hundreds of different hydrocarbons moving through the refinery, Union Oil can't possibly risk product contamination. That's why they use Hamer Line Blinds. Hamer Line Blind Valves not only provide a permanent, positive leakproof shut-off, but are unsurpassed for long service-life and lasting safety. In addition Hamer Line Blinds are fast, simple to operate. One man can open or blind a line in one minute. Costly down time is reduced. Operational efficiency is vastly increased.

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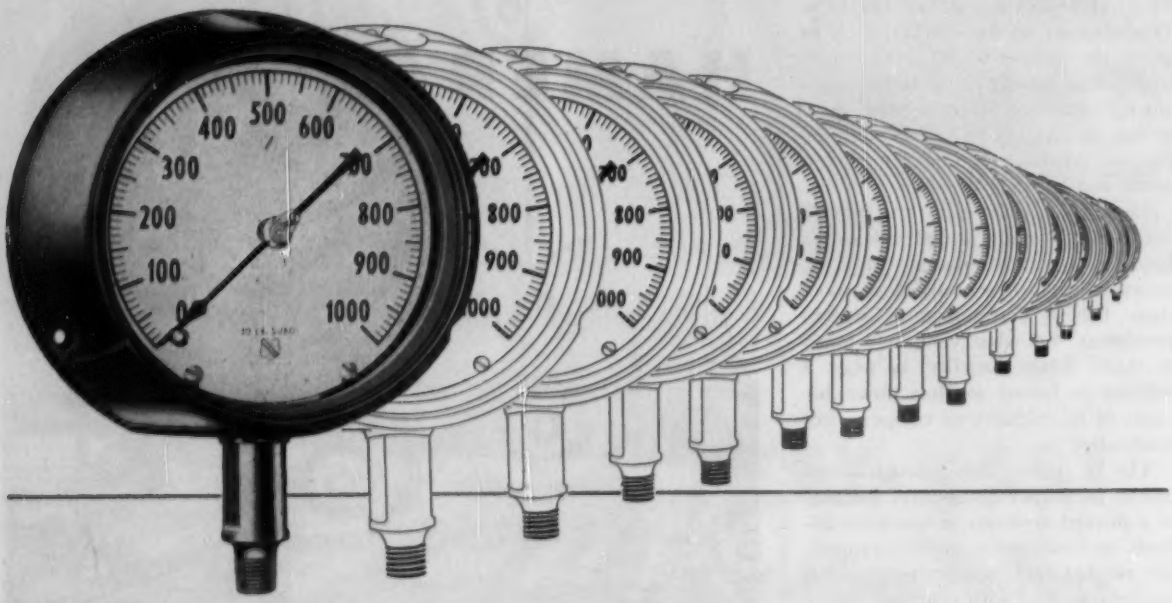

Service Conditions primarily determine the pressure gauge you specify for your installation. The wrong gauge can cost time, trouble, and money.

That's the big reason why Ashcroft Duragauges make sure of your complete satisfaction by offering a multiple choice in case designs and materials, Bourdon tube materials, ranges, movements, and dial sizes. Briefly, you can select the right gauge for your requirements from:

Cases of 3 different materials in 8 service-proved designs.

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Pressure Ranges from 30" vacuum or a few ounces through 100,000 psi.

Rotary Geared Movements that include the famous "Nylon Movement" or all stainless steel.

Dial Sizes from 4½" through 12".

Most important, Ashcroft Duragauges provide that unbeatable combination of highest sustained accuracy and durability of any pressure gauge built.

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MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

or pass on the costs to the consumer will continue. The future contains many other fringe demands by the unions. The government is also entering into the "social fringe" field and when it does payment will come out of taxes paid in large part by industry. Thus, industry in the future must make a realistic appraisal of the whole field of "fringe benefits" so it may operate profitably and may continue the advantages and security fringe benefits offer.

The Future of Industrial Communications

There has been much talk and literature on employe communications. Companies are spending substantial sums on employe information programs. The importance of communications, formal and informal, has been increasingly emphasized in recent years. Theories of communications have been developed. Techniques for improving communications have been devised. Private industrial relations consulting firms are flooding the market with communication literature designed to better inform the employe and influence his attitude. But strangely enough no one appears as yet to have come forward with any constructive method for measuring the effectiveness of industrial communications.

Many companies have used the tried method of employe opinion sampling. Experience has shown that very few of these surveys reveal a negative opinion. As a rule the employe likes anything he receives in the way of information, since it costs him nothing and he can either read it or discard it as he wishes. The surveys reveal the workers are interested in receiving material, but the question which remains is, how effective is the program and what has it accomplished?

Communications just doesn't happen in industry other than the ever-present "grapevine." Even where there is a systematic plan for employe communication there are difficulties and obstacles to overcome, if the effort is to prove effective. An authoritarian atmosphere will prevent the free flow of communications. It is unlikely that information can be transmitted fully and accurately where there are too many supervisory management levels. An unfriendly

... make every step a safe step

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Outdoors or indoors, throughout your plant, you can provide safe walking conditions on catwalks, stair treads, walkways, platforms and floors. For Blaw-Knox Electroforged Steel Grating brings you these exclusive features:

1. rigid one-piece construction—easy to install
2. non-slip twisted crossbar—for safe footing
3. three types of bearing bars
   - square bars—for smoothest walking surface
   - knurled bars (Furro-Grip)—for extra safety plus relatively smooth walking surface
   - serrated bars—for maximum safety under extremely hazardous skid conditions
4. no sharp corners to clog—self-cleaning
5. all surfaces accessible—easy to paint
6. maximum open area—for light and ventilation

Write for your copy of new Bulletin No. 2486 —or send dimensional sketch for quotation.

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GRATING APPLICATIONS: floors • platforms • walkways • catwalks • stair treads • fan guards • shelving • and many other uses, both outdoors and indoors, for versatile steel grating

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HOW YOU BENEFIT WITH GIRDLER CATALYSTS

Cuts consumption of nickel 50% with

GIRDLER G-12 CATALYST

at Celanese Plant, Bishop, Texas

APPLICATION: Hydrogenation, employing a nickel type catalyst.

TECHNICAL SERVICE: Girdler engineers suggested installation of a supplementary G-12 catalyst case for further purification of the hydrogen.

RESULTS: Has cut consumption of expensive hydrogenation catalyst in half.

Technical personnel of the Girdler Catalyst Department will gladly assist you in your catalyst problems. Write for a copy of Bulletin G 260.,

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As Management Sees It . . .

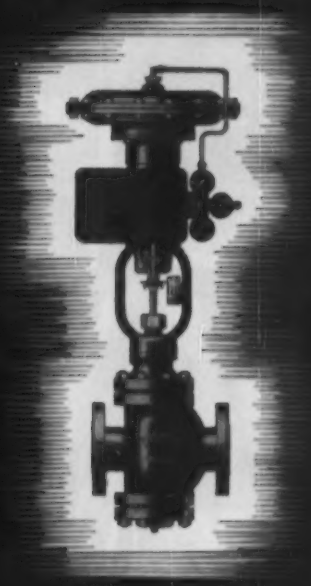
union can do much to undermine any communications program. There may be too much talk at employes and not enough listening. Most often there is a tendency to forget that communications is a two-way thing.

Perhaps the most important effect of communications begins with the chief executive. He does much to decide the effectiveness of receiving and disseminating information. If he is a good communicator and points out the values of good communication to his associates, the foundation for a good program is there. But when support from this source is lacking, it becomes very difficult to operate an effective communications program. These and other barriers, although not unsurmountable, often limit the value of a company's communication program.

Employe communications will grow in the future. It has a definite part to play in employe-employer relations, but there will be much soul-searching as to the programs' effectiveness. Even the industrial consulting firms with "packaged" employe communication programs are in the process of reappraising their material. The goal of communications may be summarized in two words, information and attitude. Communications is only effective where the employes are fully informed and supplied with the facts. Correcting working information is as important as supplying the facts.

In the future communications will have to be strengthened to work two ways, so that management may be fully informed of employe attitude and employes of management's view. Ways will be found to test the effectiveness of employe communication programs. Many different persons and groups have spoken, claiming to know what the worker is thinking and what he is after. The future through study will develop better communication techniques to determine what the worker wants to hear rather than what is thought he wants to hear.

This, then, is the future in industrial relations. Its effect will be felt by everyone. The engineer of today must think of tomorrow, not only concerning engineering problems but in the field of industrial relations if he is to keep abreast of the changing times. ##



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TELLS YOU THAT IT IS CUSTOM DESIGNED, ENGINEERED AND MANUFACTURED TO FIT YOUR APPLICATION—WITH THE ULTIMATE IN DEPENDABILITY, ECONOMY AND TROUBLE-FREE PERFORMANCE

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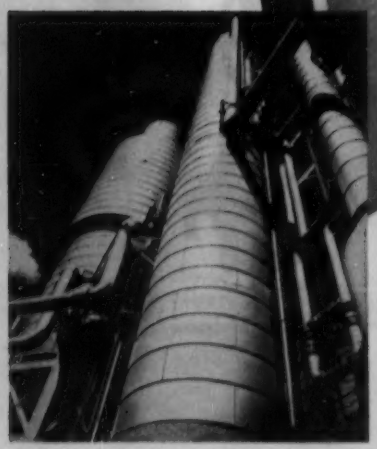
STRUCTURAL STABILITY—
Low-cost carbon steel backing provides necessary strength and rigidity.
DESIGN FREEDOM—
Integral bond allows design and fabrication of shapes to meet process and space needs.
ECONOMY—
High-alloy layer assures corrosion resistance, long equipment life.



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CLAD STEEL EQUIPMENT GIVES SOLID HIGH-ALLOY PROTECTION AT LOWER COST

With protection against the corrosive action of sulfuric feeds at high temperatures a "must" to avoid unscheduled shutdowns, clad steel equipment is often the *economical* answer. Cladding and backing are permanently and integrally bonded over their entire surface, eliminate the chance of seepage or crevice corrosion. Smooth, uniform clad surfaces permit easy cleaning, drainage and inspection.

Why not investigate clad for your new processing equipment. Lukens Clad Steels—stainless, nickel, Inconel, Monel, copper—give you all the advantages of these solid high-alloys with savings up to 50% in material costs.

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LUKENS CLAD STEELS

STAINLESS-CLAD · NICKEL-CLAD · INCONEL-CLAD · MONEL-CLAD

PRODUCER OF THE WIDEST RANGE OF TYPES AND SIZES OF CLAD STEEL PLATES AND HEADS AVAILABLE

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Industrial Hygiene

(Continued from Page 103)

being by cooperating in the use of safe techniques or equipment.

Hygienist at Work—The principal province of the hygienist in industry is to guard employes against the assimiliation of toxic substances through:

1. Ingestion.
2. Skin contact.
3. Inhalation.

Because petroleum materials are not usually taken internally, complaints due to ingestion are rare. Skin ailments are more common, though they do not occur as frequently as in many other industries. Much more important is inhalation, a major consideration in the health of workers. "Practically all solvents and chemical gas poisoning is due to inhalation," Hammond has said, "and if you stop their inhalation, you will stop most occupational systemic intoxication."

Through these three avenues the worker may assimilate harmful materials which Hammond has classified as follows:

• **Irritants,** such as ammonia, aldehyde, organic acids and chlorine.

• **Asphyxiants,** such as carbon dioxide, nitrogen and acetylene. Asphyxiants produce suffocation in the manner of drowning by blocking oxygen from the lungs.

• **Volatile chemicals,** such as benzene, methanol, dioxan and turpene which exert influence on organs other than the lungs. Benzene works on the bone marrow, methanol on the optic nerve, dioxan on the kidneys, and turpene on the bladder.

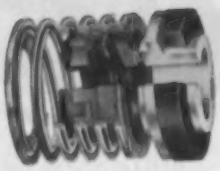
• **Organo-metallic materials,** such as the metal carbonyls and tetraethyl lead. There is no reasonably safe concentration of these two chemicals in the breathing atmosphere.

• **Inorganic vapors,** such as mercury.

• **Hygienic aids.** Of importance to the hygienist as a guardian of employe health is the practice, now compulsory in many states, of labeling products according to their degree of hazard. These recommended labeling

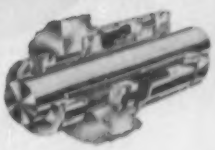
3 JOHN CRANE Shaft SEALS
for lifetime performance in any petroleum or petrochemical service

TYPES 1 and 2
Synthetic Rubber Bellows • For Low Pressure Service



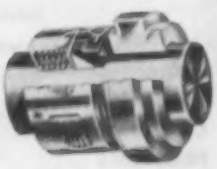
Services: gasoline, diesel fuel, fuel oil, crude oil, butane, propane, ethane and similar products non-injurious to synthetic rubber.
Pressures: to 200 psi.
Temperatures: —40°F to +212°F.
Construction Data: Factory assembled. Self-adjusting sealing head. Lapped faces positively prevent leakage. Low spring pressure for minimum wear. *Available in balanced construction for pressures to 550 psi.*

TYPE 8B
Packaged Type Seal • For High Pressure Service



Services: Same as Types 1 and 2.
Pressures: to 1200 psi.
Temperatures: —40°F to +250°F.
Construction Data: Heavy duty. Hydraulically balanced to handle high pressures. Single-unit package for easy installation.

TYPE 9
Sealing Members Made of Teflon* • Engineered for service conditions that do not permit use of rubber



Services: alkyl benzine, benzine, creosote, silicone oil, some petroleum derivatives, and all known corrosives.
Pressures: to 150 psi. (balanced construction to 750 psi.)
Temperatures: —120°F. to +500°F.
Construction Data: Furnished in the metallurgical specification best suited to the particular service. Flexible wedge ring and sealing ring molded from chemically inert Teflon.

Contact "John Crane" for the shaft seal best suited to your requirements. Request bulletin giving full information on "John Crane's" complete line of mechanical seals.

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JOHN CRANE CRANE PACKING COMPANY 30 YEARS INDUSTRIAL PROGRESS

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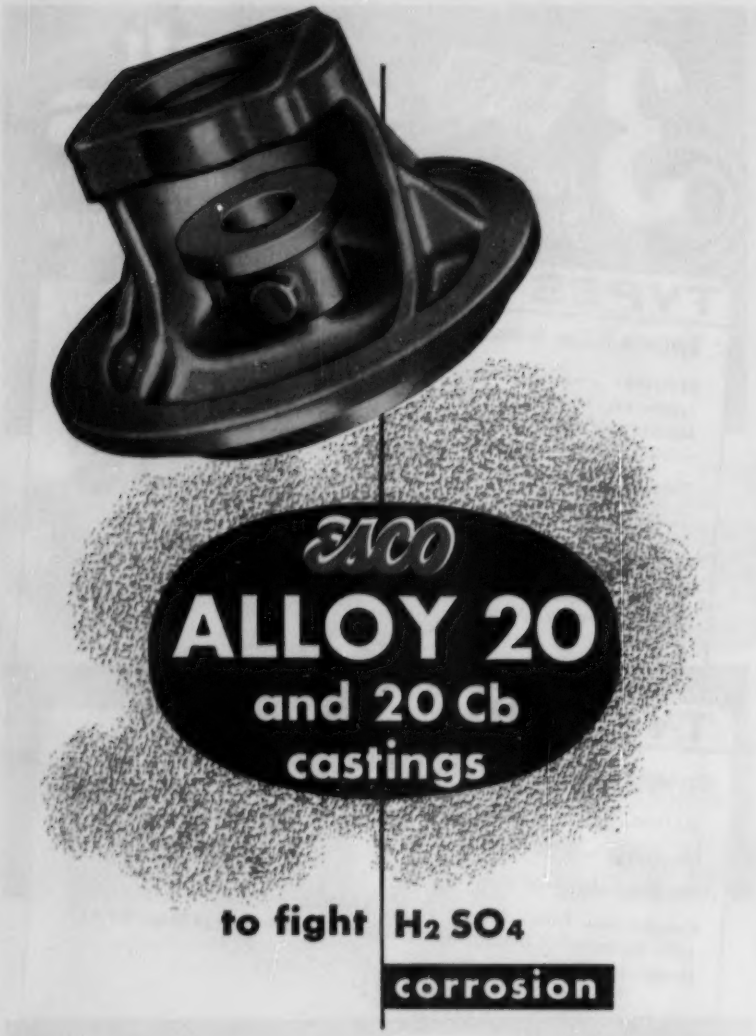

Now you can specify *ESCO* Alloy 20 and 20Cb stabilized castings in wall thicknesses and dimensions to meet your most exacting requirements. Static, Spuncast® and Shellcast facilities are available as needed.

THE TOUGHEST CORROSION PROBLEMS WIND UP AT . . .

***ESCO* Alloy 20 and 20 Cb Cast Fittings are available from stock.** See your *ESCO* distributor, or write direct.

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As Management Sees It . . .

procedures are established through the joint efforts of many groups and are usually revised and published periodically.

According to Hammond, Maximum Allowable Concentrations, now available on about 200 materials, can serve as guides in evaluating and estimating potentially hazardous areas. This list of values is not static; it is dynamic. It changes according to animal experiment data and clinical information based on experience with industrial exposure of humans. To apply properly MAC values in evaluation of atmospheric exposure to gases and vapors, it is necessary that accurate measurements be made. This is the work of the industrial hygienist along with other activities. He is trained to measure micro quantities of materials that may have an effect. It is important that he use the very best references.

To insure further a healthful environment, many companies have health and safety committees or health and sanitation committees. The membership consists of representatives of the principal operating departments, and the chairman may be the general manager or general superintendent of a large operating department. Often there are also subcommittees which report to the main committees on phases of industrial hazards.

For the protection of both the consuming public and industry employes, many companies also have toxicity committees. Composed of appointees from various departments, these committees screen new materials and chemicals before they are adopted for company use; investigate possible hazards of products which may be manufactured and sold; and recommend proper labeling of products.

This description of several phases of the application of science to environment control, industrial hygiene, in the petroleum industry points up the work done by the team of specialists and management men in combating today's most complex and subtle health hazards. Information from toxicological research groups, from public health agencies and from trade journals identify danger spots which today's enlightened management can then control before employes are exposed. ##

EXPLOSION PROOF

IN THE PRESENCE OF...

Totally enclosed explosion-proof Century motors insure complete confidence with many features.

A few are:

- Vital parts protected – Sealed in
- Reverse rotation without changing fan
- Uniform ventilation
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- Lubricated for years – but *CAN* be serviced on the spot.

Ethyl ether vapors

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Petroleum

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Class I, Groups C and D
Explosion-Proof Motors

Underwriters Approved

Three phase: 1 to 100 H.P.
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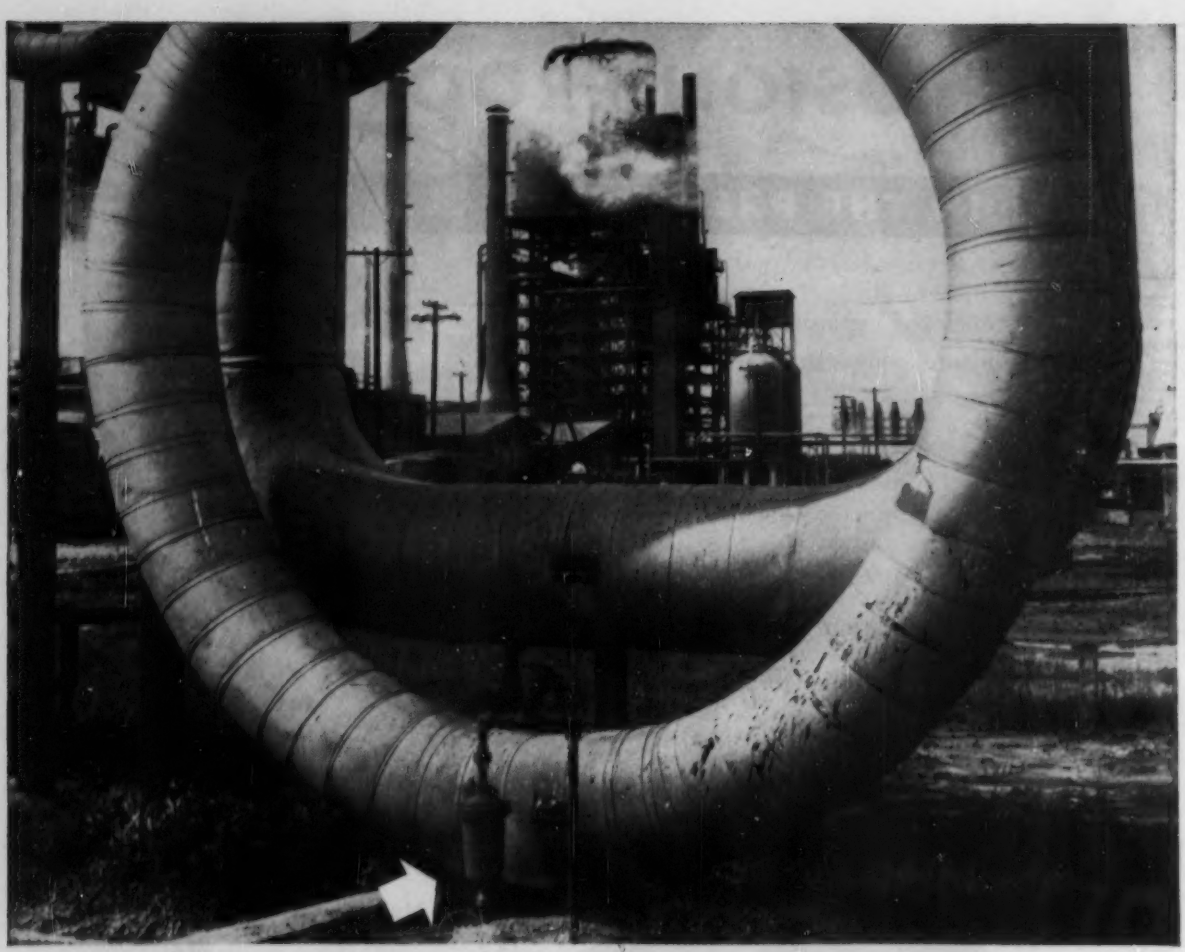

Look Ahead When You Specify Steam Traps...

100 or 1,000 or 10,000 steam traps in a plant are a small item in relation to the processing equipment that depends upon them. But if they are troublesome, headaches are just multiplied by the number in use. It hardly pays, then, to be pennywise in specifying traps.

Perhaps the biggest single consideration in choice of traps should be their long-range performance. Look ahead—will the traps do the job? Will they stand up? Will they require frequent maintenance?

No traps in the world have ever turned in better performance records than Armstrongs. And, here is why:

Design—simple... only two moving parts . . . "frictionless" free-floating leverage . . . heavily reinforced for wear . . . generous safety margins.

Materials—file-hard chrome steel valve and seat, hardened, ground and lapped together. All other parts corrosion-resistant stainless.

Experience—designed and built by men with more inverted bucket trap experience than any other organization.

Inspection—quality control is not by sampling—*every trap* is tested before shipment.

Guarantee—satisfaction or your money back.

When you specify Armstrong traps you can look ahead to long, long trap life with infrequent maintenance. Ask your Armstrong Representative to give you details or write:

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ARMSTRONG STEAM TRAPS

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... 44 pages of practical data designed to give you better trapping. Free on request . . . no obligation.

S75

What's Happening . . .

. . . in the Industry

U. S. Refining Capacity Hits 842,630 Barrels

The U. S. had a total of 326 petroleum refineries both operating and shut down on January 1, 1955, according to figures soon to be released by the Bureau of Mines. Another four plants were under construction.

The daily crude capacity of the country's 326 operable plants amounted to 8,420,630 barrels, while their daily cracking capacity equalled 2,535,434 barrels. The four refineries under construction represented an additional crude capacity of 146,800 barrels a day.

Ethyl Survey Shows Rise in Octane Ratings

Premium-gasoline antiknock quality rose to a nation-wide weighted average of 95.6 octane number in June, according to Ethyl Corporation's latest survey. This was .3 number higher than in May and 2.0 numbers higher than in June 1954.

Regular grades hit a new high of 88.3 number in June, as compared to 88. reported in the survey for May. Average tetraethyl lead contents for June were 2:58 ml per gallon of premium and 2.22 ml per gallon of regular.

U. S. Refineries Produce Over Half World's Output

Petroleum refining in the U. S. accounts for just over half the world's capacity, according to a conversion of figures released by Britain's Petroleum Information Bureau. The agency's tabulation, showing the location of world oil refining capacity at the end of 1954, was converted from metric tons per year to barrels per day by using the table of "Representative Weights of Crude Oil by Countries of Production," appearing in API's *Petroleum Facts and Figures.*

The conversion shows U. S. operable capacity, both in use and shut-down, as being 8,513,000 barrels a day, as compared to the world's total daily capacity of 16,531,000 barrels. This figure for the U. S. is in line with a report soon to be released by the Bureau of Mines.

Outside the U. S., Western Europe has become the leading area with a daily capacity of about 2,128,000 barrels. Leading refiners in the area include France, Italy and the United Kingdom, each with more than 450,000 barrels a day capacity. Others contributing to the total are Germany, Sweden, Spain and the Netherlands.

The growing importance of oil refineries in the British Commonwealth was brought out by the report of some 1,325,000 barrels a day capacity in India, Borneo, Australia, Canada and the U. K. alone. Additional refineries either are under construction or have been completed since the report in Australia, India and other Commonwealth countries. The U. K. and Canada are by far the most important members of the group.

WORLD OIL REFINING CAPACITY

Thousand Barrel Average Daily Capacity at the End of 1954*

	1954	1953	1938
U. S. A.	8,513	8,308	4,581
U. S. S. R. Bloc	1,425	1,230	678
Netherlands West Indies	656	667	430
Canada	598	541	177
U. K.	588	572	38
Venezuela	519	446	82
France	511	496	144
Persia	†501	501	220
Italy	454	395	44
Mexico	250	238	96
Netherlands	236	236	15
Germany	215	179	47
Indonesia	217	209	154
Bahrain	205	205	32
Argentina	185	167	94
Saudi Arabia	195	231	...
Japan	147	129	51
Trinidad	116	116	70
Aden	102	...	...
Belgium	98	90	123
Israel	88	88	...
Egypt	66	49	18
Australia	57	18	‡
British Borneo	49	49	20
Peru	49	39	23
Colombia	40	33	13
Brazil	42	12	‡
Sweden	37	37	4
Spain	37	31	2
India	33	6	‡
Canary Islands	30	26	3
Others	222	174	67
World Total	16,531	15,478	7,417

* Data based on Petroleum Information Bureau figures in thousands of metric tons; weight-to-volume conversion factors found in "Representative Weights of Crude Oil, by Countries of Production. In International Trade," Petroleum Facts and Figures, 11th Edition.

‡ Included under Others.

† Estimated figure shown is capacity prior to nationalization.

Safety Is the Same Everywhere—

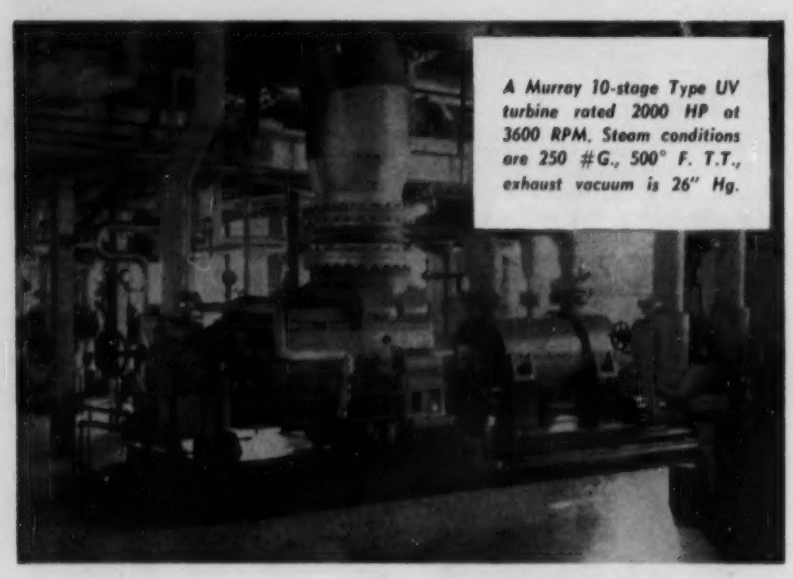
East meets west at a recent session of the National Safety Council's Safety Training Institute in Chicago. Among the 40 members of the class studying the fundamentals of industrial safety were four petroleum safety men—two from India and two from the U. S. Left to right are D. K. Sirkar, fire marshal, and S. Jagannathan, training and safety supervisor, both of Standard Vacuum Refining Company of India, Ltd.; D. W. Powell, safety and fire prevention, Sohio Petroleum Company, Covington, Ky., and E. M. Evans, safety engineer, D-X Sunray Oil Company, West Tulsa, Okla.

U. S. Petrochemicals to Hit $4 Billion Mark This Year

Almost $4 billion in petrochemicals will be produced in the U. S. this year, a Shell Chemical Corporation executive reported at the Fourth World Petroleum Congress in Rome. J. P. Cunningham, with the company in New York, told delegates that by 1965 natural gas and products from refinery operations will be used in as much as 50 percent of the country's chemical production of all types.

He cited World War II, with its sudden need for synthetic rubber, as an important factor in spurring petrochemical development. He viewed participation in buta-

Murray Turbines



A Murray 10-stage Type UV turbine rated 2000 HP at 3600 RPM. Steam conditions are 250 #G., 500° F. T.T., exhaust vacuum is 26" Hg.

● The Murray Type UV turbine pictured above has been driving a high pressure lean oil pump in a Southwestern refinery for the past 10 years. And is still giving dependable, trouble-free service.

Murray mechanical drive turbines both single and multi-stage can be furnished in a wide range of ratings for steam pressures ranging from 0 to 600 #G., condensing and non-condensing. Types in the higher pressures available for up to 250 #G. back pressure.

MURRAY IRON WORKS COMPANY
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Builders of Steam Power Equipment for Three Quarters of a Century

What's Happening. . .

diene and snythetic rubber manufacture as a promising field for growth.

Another expert reporting to the congress was P. H. Frankel, British economist. He said that within 13 years Europe's coal and hydroelectric production will fall hopelessly short of the rising demand for power. Barring an unexpected development of nuclear power, the gap can be filled only with an increased use of oil.

At present, Western Europe receives only 10 percent of its energy needs from liquid fuels, while coal supplies some 78 percent, hydroelectric power 11 percent and natural gas less than 1 percent.

Commission Drops Inquiry Into Additives Advertising

Federal Trade Commission will not investigate gasoline-additives advertising because such a study would be too expensive. Edward F. Howrey, chairman, told the Senate Appropriations Committee that laboratory procedures are not feasible for an investigation. Pointing out that the commission has the burden of proving advertisements false or misleading. Howrey said his agency consulted the Bureau of Standards and was told that an investigation would be too expensive.

Another commission spokesman, Harry A. Babcock, director of its Bureau of Investigation, told the Senators that the Bureau of Standards reported it would have to duplicate all the experimental work by the big companies. The cost would run into millions.

Tennessee Gas Buys Two Oil Refineries

Tennessee Gas Transmission Company, which entered the petrochemical industry with its recent purchase of a half interest in the government's butadiene plant at Houston, now plans to take up refining. The company will acquire two refineries in its purchase of Bay Petroleum Corporation. One plant is in Denver and the other is in New Orleans. More than 96 percent of the outstanding shares in the Bay company were voted in favor of liquidation. The consideration is about $19 million.

Enjay Opens Laboratory Devoted to Petrochemicals

A new laboratory devoted to the technical side of the petrochemical marketing business has been opened at Linden, N. J. Housing 11 separate laboratories, plus office space, the new $1-million facility will serve as the scientific arm of Enjay Company, Inc., Standard Oil Company (New Jersey) affiliate marketing petrochemicals.

Known as Enjay Laboratories, the new plant was built on the grounds at Esso Research Center to allow laboratory personnel to rely on Esso scientists for some skills. Technicians at the plant will conduct research on additives for fuels and lubricants, chemical intermediates and Butyl rubber, and seek new ways petrochemicals can be adapted by various manufacturers.

A new wing of the building, now under construction, eventually will double the

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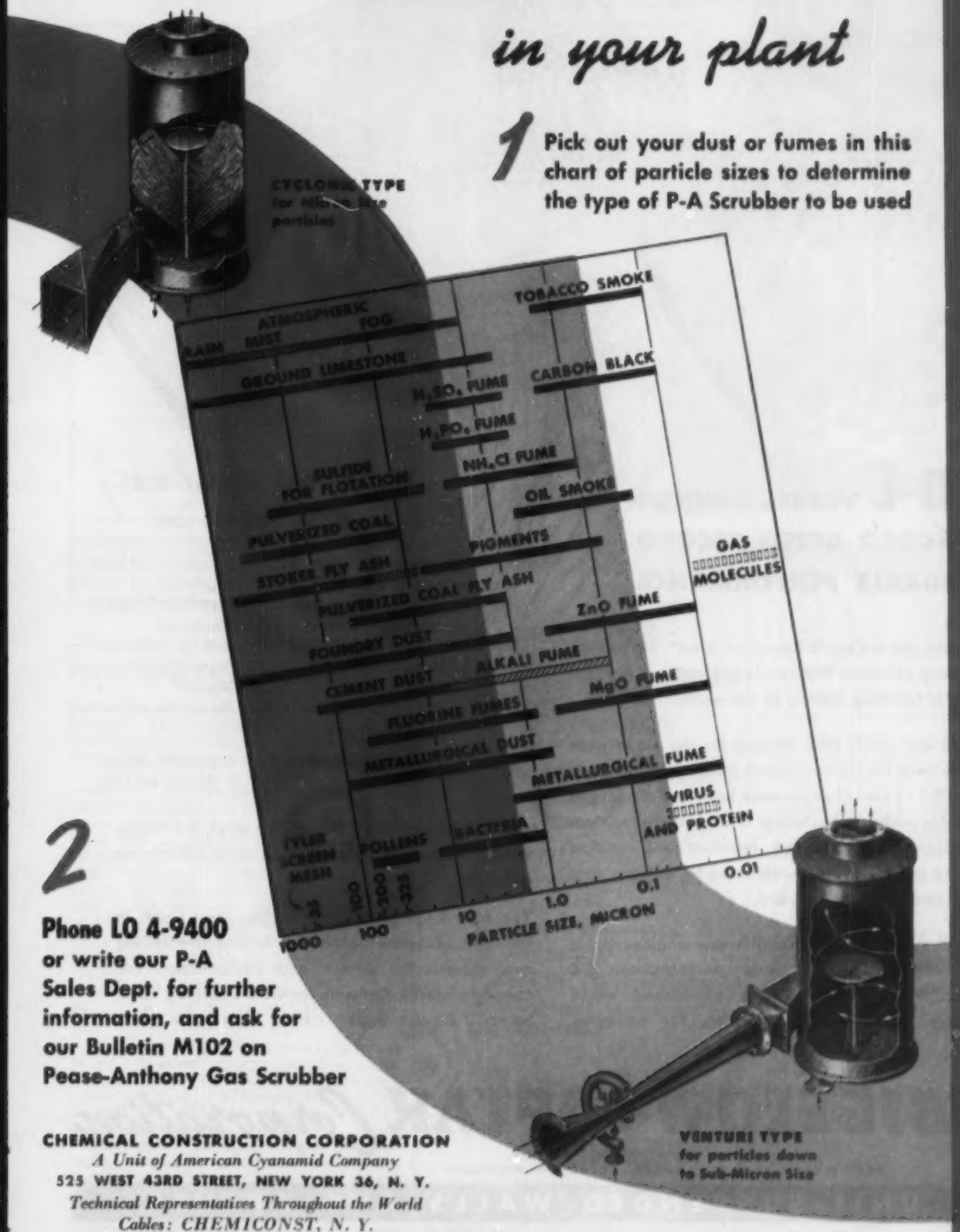
1 **Pick out your dust or fumes in this chart of particle sizes to determine the type of P-A Scrubber to be used**



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From Regina to Saudi Arabia

B-L VESSEL LININGS SET RECORD AFTER RECORD FOR DEPENDABLE PERFORMANCE

It looks like a Cook's Tour—but it isn't. Instead it's a listing of recent Bigelow-Liptak refinery installations in far-flung corners of the world.

There are good, solid reasons for this world-wide preference for Bigelow-Liptak jobs. In the first place from B-L's years of experience has come a *complete castable package*. Insulating- and abrasion-resistant castables are *engineered, furnished* and *installed* by the same company—which means just one contract and one responsibility.

The overall result of this all-in-one engineering is exceptional durability and performance. B-L refractory installations have established world records for continuous operation. For example, after initial runs of 785 and 610 days, B-L linings were in perfect shape—required no repairs during shutdowns.

Yes, from Regina to Saudi Arabia—and points in between—Bigelow-Liptak installations are setting new records for service and performance. For complete information write for the B-L catalog "One Source". Do it today!

A FEW OF OUR RECENT JOBS

● Montreal, Canada	Regenerator
★ Regina, Canada	Regenerator and Cyclones
● Batangas, Philippines	Regenerator and Cyclones
● Yokohama, Japan	Regenerator and Cyclones
★ Ras Tanura, Saudi Arabia	Regenerator—Reactor
● Copenhagen, Denmark	Kiln-Reactor
● Antwerp, Belgium	Kiln
● Norco, La.	Regenerator and Cyclones
● Altona, Australia	Reactors
● Mandan, North Dakota	Regenerator and Cyclones
and NOW!	
● Anacortes, Washington, U. S. A.	Regenerator, Reactor, Cyclones and Lines.

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4879

What's Happening. . .

some 18,000 square feet of laboratory space. The new wing will handle projects dealing with Butyl rubber. Two other Jersey Standard affiliates, Esso Standard Oil Company and Humble Oil & Refining Company, recently acquired Butyl plants.

CHEMICALS WANTED

The National Registry of Rare Chemicals, Armour Research Foundation of Illinois Institute of Technology, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

N-Methyl isoindole
Borazole
1,3-Di-tertiary butyl benzene
Diphenyldecapentene
Benzyl selenomercaptan
Cyclohexanecarboxaldehyde
3-Methyl-2-naphthoic acid
4-Methyl-1,4-heptanediol
ortho-Tolyl disulfide
Anthracene-9,10-dicarboxylic acid
1,2-Difluoroethylene
2-Aminocyclopentene-1
5-Nitro-2-n-propoxyaniline
Methylene fluoroiodide
Di-1-naphthoyl peroxide
Phenyl dimethyl phosphine
1,6-Heptadiene
2-Benzoyl-1,3-diphenyl-1,3-propanedione
2-Bromo-3-nitroaniline
1-Bromo-1-chloroethane

Atmosphere Sampled Over West-Coast Plant

Samples of the atmosphere above its El Segundo, Calif., refinery are being taken by Standard Oil Company of California as part of an effort to prevent pollution. The company is studying the atmosphere by means of specially-designed instruments suspended above the refinery. The instruments, during testing periods, are held aloof and in place by a 1000-cubic-foot balloon.

Several months will be required to make initial tests with a series of instruments, and additional time will be needed to study results, which will be correlated with other scientific studies being made of the air-pollution problem in the Los Angeles basin.

Deep Rock Sells Refineries

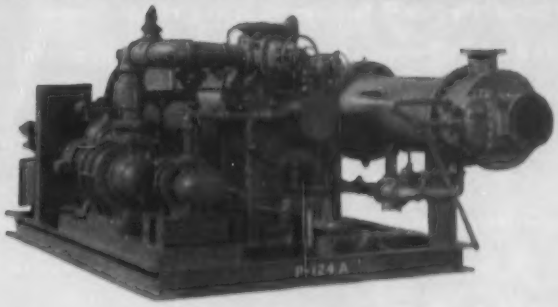
Deep Rock Oil Company has disposed of its remaining refinery facilities, transferring them, along with the company's marketing and distribution facilities, to Kerr-McGee Oil Industries, Inc., for $17 million in preferred stock.

With other changes in the company came plans to change its name to Crescent Corporation. The new name was to have been submitted to the stockholders early this month.

Deep Rock is transferring to Kerr-McGee $5 million in cash and $12 million in assets. A cancellable lease Deep Rock had retained on the Cushing, Okla., refinery it sold to General American Oil

The upper unit illustrated is a portable R-C Inert Gas Generator, oil-fired, with capacity of 35,000 cfh. The lower unit is a stationary type, gas-fired, with capacity of 50,000 cfh.

PROTECTION at your finger tips with R-C INERT GAS GENERATORS



CHECK THE R-C "BIG 4" ESSENTIALS

1. Compact units, portable or stationary
2. Choice of gas or liquid fuels
3. Low cost per cubic foot of capacity
4. Little supervision or maintenance

You can find this combination of values only in R-C Inert Gas Generators.

Quick availability of smothering inert gas to reduce fire or explosion hazards not only protects against accident or property damage, but frequently results in lower insurance costs which often repay the cost of the equipment.

With R-C Inert Gas Generators, you can get fast action from either stationary or portable units. They can operate on either gas or liquid fuel, and their simple design permits instant readiness with little attention.

ASK FOR DETAILS

Ask the R-C engineer to point out where Inert Gas Generators can be used to advantage in your plant. Or, write for Bulletin 100-B-14.

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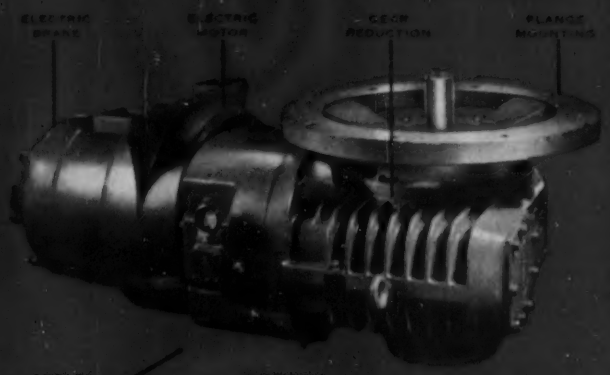
Centrifugal and Rotary Positive Blowers and Exhaustors • Positive Displacement Meters • Vacuum Pumps • Gas Pumps • Inert Gas Generators • Spiroidal Compressors



You can't beat the combination of the RIGHT horsepower, the RIGHT shaft speed, the RIGHT features all in one compact power unit that you can use RIGHT where you want it. It's the best way and the easiest way to select your power drives because you purchase one unit, handle one unit in your receiving, production, or maintenance departments . . . set one unit in place and you're ready to go.

Master Motors, available in thousands and thousands of types and ratings (1/8 to 400 HP) give you the widest selection of electric motor drives in the nation.

Open, enclosed, splash proof, fan-cooled, explosion proof . . . horizontal or vertical . . . for all phases, voltages and frequencies . . . in single speed, multi-speed and variable speed types . . . with flanges or other special features . . . with 5 types of gear reduction up to 432 to 1 ratio . . . with either magnetic or dynamic electric brakes . . . with mechanical or electronic variable speed units . . . with fluid-drives . . . and for every type of mounting . . . Master has them all and so can be completely impartial in helping you select the one best motor drive for YOU.

THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO

make it easy for yourself

MASTER ELECTRIC MOTORS

Company last summer also was transferred to the Kerr firm.

The company will continue to operate a gas-processing plant near Tyrone, Okla. It also will carry on research in the petrochemical field.

U. S. S. R. Agrees to Return Seven Austrian Refineries

Included in the economic provisions of the recently-concluded treaty with Austria is a Soviet Union agreement to hand over seven refineries to which it formerly laid claim, together with all oilfields, exploration concessions and distribution facilities. In compensation, Austria undertakes to make delivery of some 67,880,000 barrels of crude over a 10-year period.

All other "German assets" hitherto held by the U. S. S. R. will be handed over to Austria in exchange for goods to a total of $150 million in six equal annual payments. In addition to the 67,880,000 barrels of crude, Austria is expected to make six annual deliveries of some 2,036,400 barrels as part of the $150-million compensation payment.

As regards Austria's refineries, all in the former Soviet zone, three of the seven are wholly owned by Western oil companies, and two are partially owned in the West. The Shell group has a plant at Floridsdorf, and Soconoy Mobil Oil Company, Inc., claims the refinery at Kagran. The refinery at Lobau is owned equally by the Shell and Socony organizations.

Shell and Standard Oil Company (New Jersey) share a 50-percent interest in the refinery at Korneuburg with certain German interests. The refineries at Schwechart, Moosbierbaum and Vosendorf are listed as German assets, although the plant at Schwechart is owned in part by French interests.

Petroleum Industry Sets Record in Capital Spending

By September, the U. S. petroleum industry will have spent a record $2 billion for expansion of plants and equipment. A joint report from the Securities and Exchange Commission and the Department of Commerce predicts capital expenditures for the third quarter will reach $698 million, an increase of $16 million over the corresponding period in 1954. If outlay follows the forecast, more than $1,990,000,000 will be spent by the industry during the first nine months in 1955.

The largest increase during the year was assigned to the April-June period, when an estimated $802 million was spent. During the same period a year ago, only $682 million was reported. The rise for the quarter was approximately 17 percent more than the period for 1954 and almost 64 percent above the January-March period this year.

Standard Terms Offered

New standardized terms for pressure vessel shells are published in the June issue of Mechanical Engineering, published by ASME. The standard nomenclature was adopted to facilitate reading of material on shell theory and communications between independent investigators. As far as possible, nomenclature which has been in common use was utilized in the new standardized nomenclature.

Committee Investigates Discrimination Charges

A team has been assigned to investigate charges that companies and unions discriminate against Negroes at four Southwest refineries. The group, appointed by the President's Committee on Government Contracts, is expected to spend several months on the study.

In filing charges, the Association for the Advancement of Colored People alleged that discrimination is practiced throughout the oil refining industry. If the committee finds the charges to be true, government contracting agencies will ask companies to change their policies.

What's Happening. . .

Yugoslavia Makes Deal For Bulgarian Lube Oil

Yugoslavia's plans to build a new refinery at Makarska have been accompanied by a trade agreement with Bulgaria providing for an exchange of Yugoslav gas oil for deliveries of Bulgarian lubricating oil.

Meanwhile in Syria, a parlimentary oil commission is studying a proposal by a Yugoslav construction agency to build the country's first refinery, a $3-million, 12,000-barrel-a-day plant near Homs. Yugoslavia has offered to advance refinery equipment

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MODEL R
This ruggedly built instrument of laboratory accuracy is ideal for quick checking and for continuous recording of Specific Gravity of liquids under line pressure. Changes in Specific Gravity of sample are recorded with a very minimum of time lag. Foreign liquids and gases are automatically purged from sample. No moving joints or stuffing boxes to cause friction or leakage. Temperature corrected, this precision instrument is adaptable to high pressures. Hundreds are in daily use in plants and refineries of major companies. Available in 19 Models for Recording, Signalling, Transmitting and Controlling. Send for Bulletin 111R-3.
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What's Happening. . .

in exchange for Syrian agricultural products, notably wheat and cotton, to be paid back over a period of several years.

Moves Headquarters

Jefferson Chemical Company has transferred its headquarters with about 50 employes from New York to Houston. The company, owned jointly by American Cyanamid Company and The Texas Company, operates its main plant at Port Neches, Texas, and a research laboratory at Austin.

Five Sinclair Plants Receive Safety Awards

Five refineries operated by Sinclair Refining Company have received National Safety Council awards recognizing improved safety records achieved during 1954. The awards signify not only a reduced accident-frequency rate, but a rate lower than average for refineries of the same size.

The five refineries receiving awards, with their accident rates per million man hours worked in 1953 and 1954, are Corpus Christi, Texas, 6.87 and 3.59; East Chicago, Ind., 3.42 and 2.78; Hartford, Ill., 3.99 and 1.09; Marcus Hook, Pa., 5.25 and 2.74, and Sinclair, Wyo., 6.25 and 2.21.

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and
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with
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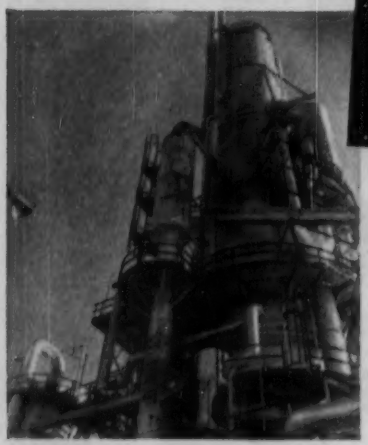

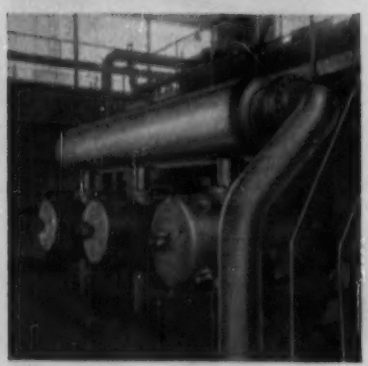

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3. the art of correcting the problem of noise, pulsation, etc. thru the adaptation of the Burgess-Manning Snubbing Principle, which has been thoroughly proved in many fields over many years.

For many problems, Burgess-Manning Snubbers are designed to integrally incorporate such plus features as air cleaning . . . or spark arresting . . . or surge control . . . or water separating . . . or heat recovery, etc.

Your noise problems can . . . and will be solved by using a dependable Burgess-Manning Snubber. Let us help you.

FREE Six case histories showing successful installations. Your specific problem may be explained. Write today.

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Dallas, Texas

Sale of Rubber Plants May Mean $415 Million

The federal government will realize a return of more than $415 million from the transfer of its synthetic-rubber plants to private ownership, according to a report to Congress from the Rubber Producing Facilities Disposal Commission.

This estimate was made as the commission recommended the sale of the copolymer plant at Baytown, Texas, to United Carbon Company for $7,153,000. Additional payments for inventories and other additions to the plant are estimated at $1,491,000, bringing the total receipts from the Baytown sale to $8,644,000.

Net book value of all plants and other assets in the synthetic-rubber producing program is estimated at $128,088,000, and the government's operating deficit since the start of the program is estimated at $132,700,000, for a total of $260,788,000.

The total amount realized from the sale of the government's 25 plants, including the Baytown facilities, is $270,796,000, giving the disposal program a recovery of more than $10 million in excess of the government's total net cost.

The balance of about $145 million to make the $415-million return to the government, represents amounts paid by plant purchasers for inventories, spare parts, net additions to plants and finished rubber, plus the return from the operating agency's cash balance and other cash generated by the liquidation of the government's plant facilities.

A further cash return will result from the disposal of some 447 pressure tank cars still owned by the government. Their $1,008,000 book value is included in the book value listed above.

In addition, the government still owns two plants, its Akron, Ohio, laboratory and some miscellaneous equipment.

Increased Use Seen For Atomic Power

Half the new electric-generating capacity being installed in the U. S. by 1975 will be powered with atomic energy, a member of Congress' Joint Committee on Atomic Energy has told the Pennsylvania Grade Crude Oil Association. Speaking at the association's annual meeting, Representative Cole predicted that by 1985 about 25 percent of all electricity generated in the U. S. will be produced by atomic energy.

Cole said Western Europe is a more profitable field for early utilization of atomic energy. He cited the area's need for oil imports, its dwindling coal reserve and limited opportunities for expanding hydroelectric facilities. Other areas offering opportunities for early use of the new power include Africa, South Asia and Latin America, all areas where conventional power is expensive.

Dow Absorbs Subsidiary

Versenes, Inc., a Farmingham, Mass., company purchased last fall by The Dow Chemical Company has been absorbed by the parent company. Manufacture of a series of chelating agents will continue at the Farmingham plant, but the sales and development functions are being transferred to Dow's headquarters in Midland, Mich. Versenes became a subsidiary after Dow

PETROLEUM CHEMICALS DIVISION

NEWS

July ★ One of a Series of Interest to the Petroleum Industry ★ 1955

NEW TECHNICAL BOOKLET ON GREASE ADDITIVES

Du Pont "Ortholeum" 300 and Phenyl-alpha-Naphthylamine have long been effectively used for stabilizing greases. In the past, however, there has been little information published on the properties, uses, methods of addition and evaluation of these additives.

This information is now available to grease compounders in a new four-page booklet. To get a copy, just ask one of our representatives or regional offices for "Stabilizers for Grease."

Many Du Pont Films Available to the Petroleum Industry

Over 40 different 16 mm. movies, covering a wide range of subjects are readily available to you through the Du Pont Petroleum Chemicals Division.

Many of them were specifically designed and produced to help the oil industry promote its products and do a more comprehensive public relations job. Most recent of these is entitled "When the customer says 'KNOCK.'" It will give your dealers a quick, clear visual education on how to answer knock complaints in a salesmanlike way. Other full-color Du Pont films of particular interest to the industry include "What Makes a Gasoline Good," and "Pipeline on Wheels," which shows the public how petroleum products tank trucks are designed and operated for maximum highway safety.

To provide extra entertainment at dealer meetings and other gatherings, a library of Du Pont "Cavalcade of America" TV films is also available on loan. This series includes a documentary film on the famous Spindletop well.

Ask any of our representatives for more details on obtaining these films for your own use.

The service station operator is your most important link with the market

THE SERVICE STATION OPERATOR is generally an independent sort of fellow by nature. And he has his own opinions about customer credit, promotion, price wars, handling employees, and many other important aspects of service station operation.

What does he *really* think . . . and how can this affect your marketing program? A new Du Pont survey can help you answer these questions.

HOW MUCH does the average service station operator know about the quality features of the products he sells? The new Du Pont dealer survey can give you a realistic, unbiased answer.

The results of the new survey—entitled "The Service Station Operator"—are to be published in a series of five reports. The first report is already off the press and is now being distributed to oil company marketing executives. The other four reports will be issued periodically during the next twelve months.

Impartial

Sponsored by Du Pont, the survey was conducted on a completely impartial basis by National Analysts, Inc. It is nationwide in scope and part of the continuing market research work of the Du Pont Petroleum Chemicals Division. It follows the recent Du Pont survey of service station customer buying habits.

To meet industry need

The survey was initiated because it was widely felt that the oil industry had a real need for more information about their dealers and dealer operations. The questionnaire itself was prepared after discussion with oil company market research groups and members of the Marketing Research Committee of the American Petroleum

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED *Dealer Survey*

Institute.

Using the scientifically accurate area sampling method, the survey consisted of personal interviews with 2,633 service station operators. This sample is representative of all the operators in the United States. But the results can be broken down and cross tabulated to give a true sample of any of four different regional divisions.

What was studied

The first report covers such factors as station hours and rush periods, gallonage sold, customer credit, and the use of customer mailing lists.

The second report, which will soon be ready for distribution, will discuss the dealer's knowledge of the products he sells, including his knowledge of additives and their functions. It also records dealer opinions of gasoline sales assets and knowledge of pricing.

Future reports

The third report will cover dealer-supplier relationships, opinions of dealer meetings, publications, and advertising. The fourth report covers the dealer's relationship with his employees, his own background, dealer associations, his income and method of paying his employees.

The fifth report will deal with the interrelationship of all the previously discussed factors . . . such as how station hours, dealer meetings and education affect sales volume. As such, it will be an extremely penetrating and significant report.

Available to marketers

This continuing survey work is done by Du Pont for the petroleum industry. And the findings are readily available to all oil companies. In addition to the regular distribution of reports to marketing executives, the entire survey has been tabulated on IBM cards which will give a wide variety of specialized breakdowns to meet the individual needs of various oil companies. For more information about this survey, just get in touch with any of our representatives or regional offices.

ASSISTANT MID-CONTINENT MANAGER

BARRETT B. RUSSELL is assistant manager of Du Pont Petroleum Chemicals Division's Mid-Continent Region with headquarters in Tulsa, Oklahoma.

Before joining the Du Pont Company in 1950, Mr. Russell was an engineer with the Standard Oil Development Company. In this capacity he worked on catalytic cracking, jet fuels, gasoline blending, special lubricants and combustion studies both at Baton Rouge, Louisiana, and Linden, New Jersey.

At Du Pont, he has been Sales-Service Representative and Sales Supervisor in the Central Region and Technical Assistant to the Sales Manager in Wilmington.

A graduate of Massachusetts Institute of Technology with a B.S. degree in Chemical Engineering, Mr. Russell is a member of the American Petroleum Institute, Society of Automotive Engineers, and the American Chemical Society.

One simple word can spell bigger TBA profits for your dealers

More TBA items are bought from service stations than from any other source. Why? . . .

It may be pure luck . . . because the Du Pont survey, "The Service Station and the Motorist," shows that, in practically every case, the sale started with the customer's *requesting* an item — rather than any *selling* on the dealer's part.

SELLING, therefore, is the word . . . the key to increasing, or possibly even multiplying, TBA profits for your dealers.

To help you alert your dealers to the opportunities, stimulate them to do more TBA selling, we have just prepared a new booklet (No. 5) in the Du Pont "through the windshield" series. The title is "A look at the TBA buyer." The copy, based on market data collected for the Du Pont survey, "The Service Station and the Motorist," is simply written so that it will be easy for the average dealer to understand and remember.

Ask one of our representatives or regional offices for sample copies and cost information on obtaining these booklets in large quantities for your dealers.

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A-9615

Printed in U. S. A.

purchased all the stock and assets of the company in November 1954. The subsidiary status was dissolved May 31.

Oil Companies Contribute Dollar Aid to Education

The American Oil Company has set aside $35,000 for use this year in aiding privately-financed, four-year liberal arts colleges in 15 eastern states. The unrestricted grants are being distributed to various state and regional associations of private colleges, which in turn will allocate the funds to 162 member colleges.

A similar grant is being made to the state associations of private colleges in 14 Midwest states by Standard Oil Foundation, Inc., (Indiana). The foundation is making a grant of $150,000. This is the third year contributions have been made to associations in Colorado, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Montana, Nebraska, North and South Dakota, Wisconsin and Wyoming. Some 145 colleges are involved.

The American Oil Company's contributions will be felt at colleges in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Ohio, West Virginia, Virginia, Maryland and North and South Carolina.

Other grants by oil companies include two scholarships for the coming school year, valued at $800 each, awarded by the Manufacturing department of The Standard Oil Company (Ohio) to chemical-engineering students at Ohio State University and Case Institute of Technology. Sohio also had made a grant of $3400 to finance a research project in the field of boron chemistry at Cornell University.

Shell Companies Foundation, Inc., will provide $350,000 in direct aid to higher education in the U. S. this year. The money will be used to educate scientists and develop research at 41 colleges and universities during the 1955-56 academic year. The foundation was organized to administer gifts from various Shell companies.

Since the program was started in 1947, Shell has sponsored 407 fellowships and 89 research grants with a total value of $1,500,000. The allocation this year is the largest the foundation has ever provided.

The Ohio Oil Company has awarded 40 scholarships for $600 each. The awards are made annually to sons and daughters of company employes on the basis of scholastic achievement, merit and possible success. Direct grants of $500 each also will be made to privately-controlled schools attended by scholarship winners.

Three Texas Colleges Receive Research Grants

Three Texas colleges—Rice Institute, Texas A&M College and the University of Texas—have been awarded a total of $865,000 for basic chemical research. The money came from the Robert A. Welch Foundation, formed from the will of the late oil-sulphur magnate. The grants cover a three-year period.

The foundation has $21 million to spend for research. All the money has to be spent in Texas.

The stipend to Rice equals $275,000, while Texas A&M receives $275,000, and the state university is allowed $294,000. The money may be applied in either organic or inorganic research.

Sets Safety Record

Pure Oil Company's Smiths Bluff, Texas, refinery, near Beaumont, became the fifth oil refinery in the U. S. to achieve 4 million man-hours of operations without a lost-time accident. The unbroken safety record at Smiths Bluff extends back nearly two years to July 29, 1953. The refinery employes more than 1000 workers.

Canadian Output Up

Canadian refineries produced 14,283,325 barrels of petroleum products during January, as compared to 13,599,633 barrels a year before.

What's Happening. . .

Humble Lecture Courses Cover Four Subjects

The Humble Lectures in Engineering program this year will include four courses. Expected to attend will be more than 60 members of the Engineering and Mechanical divisions at Humble Oil & Refining Company's Baytown, Texas, refinery.

The series was opened in April with a course on "Pipe Flexibility," taught by Dr. N. A. Weil and E. F. Sheaffer, both of The M. W. Kellogg Company. Dr. H. H.

Yes, dehydration of vapor and liquid feed stocks in petrochemical processing is best accomplished with superior drying efficiency by use of FLORITE DESICCANT.

Most economical of the granular drying agents, Florite has a longer service life, gives a low dew point depression, and aggressively resists "poisoning effects" which permanently destroy adsorption qualities.

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YOU get even, no glare, Low Cost Lighting with Jerguson Illuminators . . . the improved illuminators that are unexcelled for gages, rotameters, etc. They give you ideal illumination with safety . . . and make possible faster, easier, accurate reading.

Jerguson Illuminators use the principle of solid wedge lighting to give you *clear, even lighting, without bright spots.* Light flows through the plastic wedge and is reflected evenly. A single bulb gives you better illumination at a cost so low that savings quickly pay for the illuminator.

Jerguson Illuminators are approved by Underwriters' Laboratories and are built in accordance with their Standard for Electric Lighting Fixtures for use in hazardous locations for Class 1, Group D Services. Made in a variety of sizes; also available in a non-explosion proof model.

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What's Happening. . .

Uhlig, a member of the Massachusetts Institute of Technology faculty, presented his second course in "Corrosion" in June.

In August, Dr. S. H. Crandall, also of MIT, will present "Mechanical Vibrations." He will be followed in November by a University of Texas professor, Dr. R. F. Dawson, who will teach a course in "Soil Mechanics."

Greece Seeks Operator For Refinery at Pireaus

The Greek government is selecting an operator for its $15-million refinery to be built at Pireaus, near Athens. The government's Foreign Trade Administration had asked for applications including evidence of special knowledge, technical organization and necessary funds to operate the 30,000-barrel-a-day refinery. Applications were to have been submitted to the Ministry of Coordination by June 30. The refinery, being built by Hydrocarbon Research, Inc., and three German firms, is scheduled for completion in about two years.

Baker Catalyst Due For Use in Sovaforming

Baker & Company, Inc., has agreed to supply catalyst to Socony Mobil Oil Company, Inc. The agreement covers an arrangement to furnish Sinclair-Baker RD-150 platinum catalyst for a group of Sovaforming units. The catalyst will be supplied from Baker's recently-completed manufacturing facilities at Newark, N. J. Two Sovaforming units using this catalyst have gone on steam, and orders have been placed to supply catalyst for at least six additional units.

Sinclair's Bender Process To be Offered by Petreco

Petrolite Corporation's Petreco Division has secured a license from Sinclair Refining Company for producing the Bender process, used in sweetening hydrocarbons in the gasoline-middle distillate range. The addition of the Bender process to its distillate-treating equipment will supplement Petreco's line of Electrofining.

By converting mercaptan to disulphide by oxidation, the process is used for sweetening gasoline, kerosine, jet fuel and No. 2 fuel. Until now used exclusively by Sinclair and its affiliates, the process has been especially applicable in the kerosine-No. 2 range.

The process calls for the addition of sulphur to the distillate, plus a small amount of alkali. The yield has been described as bright, sweet and non-corrosive.

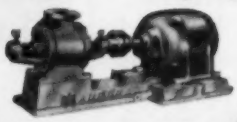
Changes Firm Name

The name of Ehrhart & Arthur, Inc., Los Angeles firm of engineers and contractors, has been changed to Ehrhart & Associates, Inc. No change in ownership or scope of operations is involved. The company is engaged in the design and erection of oil refinery and chemical process units.

Better on "1001" Pumping Duties

Capacities to 150 G.P.M.

Heads to 500 Ft.



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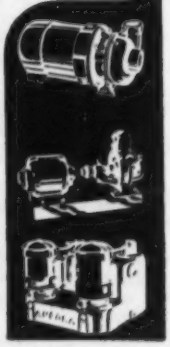
Apco—the pump with but one moving part, the impeller — is famous for long-lived, efficient performance on small capacity, high head duties. Available in Single Stage, Two Stage and 4-Stage Tandem for high pressures — and Water Jacketed for high temperature and highly volatile liquids.

Write for Bulletins 111, 111-A, 111-WJ



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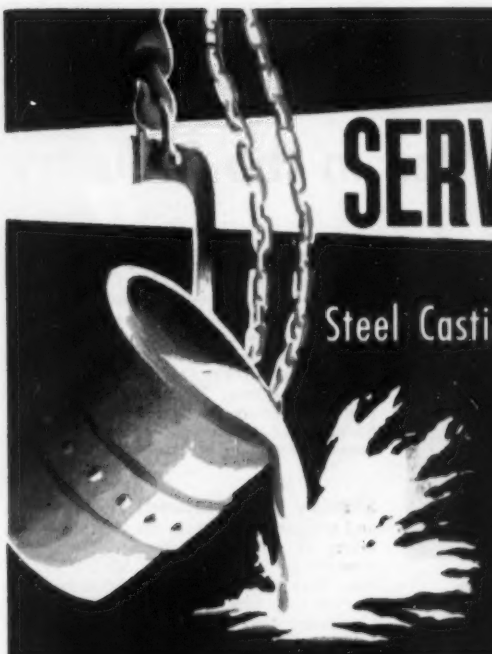

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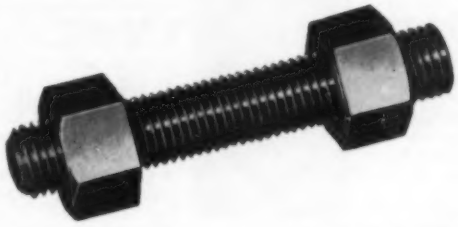

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1,300	¾" x 5½"	8,000	1¼" x 7¾"	800	1¼" x 11¾"
1,500	¾" x 5¾"	1,100	1¼" x 8"	1,000	1½" x 9¼"
2,800	¾" x 6"	8,500	1¼" x 8¼"	3,650	1½" x 9½"
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What's Happening . . .

. . . *Among Men* in the Industry

J. H. Means has been made production manager for light hydrocarbon and polyhydric chemicals at The Dow Chemical Company's Freeport, Texas, plant. Others receiving promotions in the company's Texas division were three named to superintendent's position. They are **A. C. Burkholder**, light hydrocarbon chemicals; **R. H. Smith**, polyhydric chemicals, and **T. E. Brown**, carbon tetrachloride and methyl chloride.

Alfred Moskowitz has been promoted to senior mechanical engineer in the Engineering division at Humble Oil & Refining Company's refinery in Baytown, Texas. Assigned to the division since he joined the company in 1943, Moskowitz will take up new duties in the Design department. Also receiving a promotion at the Humble refinery is **W. O. Webber**, named technical specialist in the Technical Service division. Assigned to that division since 1938, Webber will begin work on process design of light-ends recovery and processing facilities.

John W. Sylvester has been promoted to employe relations manager with Humble Oil & Refining Company at its refinery in Baytown, Texas. With the company at Baytown since 1936 and assigned to the Employee Relations department since 1938, Sylvester was advanced to assistant employe relations manager in 1946. He held that position until his recent promotion. He is a former president of the Houston Personnel Association.

Sylvester

Buell O'Conner, a chemist for Stanolind Oil & Gas Company, has been transferred to the company's new petrochemical plant at Brownsville, Texas. He was stationed in Tulsa.

E. H. McCollough is one of four new directors elected to fill existing vacancies on the API board. With Amerdad Petroleum Corporation at Tulsa, McCollough was named to succeed **E. A. Landreth**, of Fort Worth, Texas; **Thomas E. Sunderland**, of Standard Oil Company (Indiana) in Chicago, was elected to succeed **A. W. Peake**, of the same company, and **J. E. Roth**, with Tide Water Associated Oil Company in Tulsa, was named to replace **E. H. Salrin**, also of Tide Water. Landreth, Peake and Salrin recently resigned. **John F. Daley**, with The Du Pont Company in Wilmington, Del., was selected to replace the late **Ray E. Miller**, of that company.

Stewart P. Coleman, a director of Standard Oil Company (New Jersey) since 1946, has been elected vice president. Coleman joined Humble Oil & Refining Company, a Jersey Standard affiliate, in 1920 as a chemical engineer, and later was named to head Humble's technical service and development work. He joined Jersey Standard in 1933 as manufacturing representative on the Coordination committee, central study and advisory group for Standard affiliates. When the Coordination and Economics department was formed he became its first manager, and in 1954, was made chairman of the Coordination committee.

Coleman

Ray P. Dinsmore, vice president in charge of research and development for Goodyear Tire and Rubber Company, has been selected to receive the Charles Goodyear Medal for 1955. The medal, given by the ACS's Rubber division, is awarded annually for valuable contributions to the rubber and related industries. Dr. Dinsmore will receive the medal at the organization's annual meeting at Philadelphia in November.

An authority on synthetic rubber, Dr. Dinsmore has received national and international recognition for his contributions to the industry. Specific development in which he participated include the use of the rayon cord tire, Pliofilm, a rubber hydrocloride film, and Chemigum SL, a Polyiscyanate rubber. A list of his publications covers the fields of physical testing, compounding, vulcanization, theories of vulcanization, aging, processing and the economic problems of synthetic rubber.

As assistant deputy rubber director for the U. S. during World War II, Dr. Dinsmore organized and directed the research and development on synthetic rubber. He also coordinated activities of both industrial and university laboratories.

He has been with Goodyear for more than 40 years. He joined the company's experimental department in 1914 after graduating with a degree in chemical engineering from M. I. T.

James W. Foley has been made executive vice president of The Texas Company. A vice president since 1953 and a director since last year, he also is a director of Arabian American Oil Company, Trans-Arabian Pipe Line Company, Texaco Exploration Company, Colombian Petroleum Company, South American Gulf Oil Company, Coltex Corporation and The Texas Company (Iran). In 1950, he was named assistant to the chairman of the board. Foley has been with Texaco since 1932.

Kenneth A. West has been made manager of manufacturing for Canadian Oil Company, Ltd. Previously assistant manager, Dr. West succeeds **Earl A. Smith**, recently retired. He also joins the company's Management committee. Dr. West joined Canadian Oil in 1951 as chief process engineer. In 1952, he was appointed production superintendent at the Sarnia, Ont., refinery, and in 1954 became assistant manager of manufacturing.

Stanley T. Crossland, vice president and treasurer of The Texas Company, and **Harry H. Arnold, Jr.**, formerly managing director of Indonesia's N. V. Caltex Pacific Petroleum Maatschappij, have been elected directors of California Texas Oil Company, Ltd. Crossland replaces **A. Neil Lilly**, a director and vice president of The Texas Company who resigned from the Caltex board. Arnold, a vice president of Caltex, has been reassigned to New York. Before joining Texaco earlier this year, Crossland was vice president, treasurer and director of Ethyl Corporation.

Richard W. Campbell has been promoted to manager of Shell Chemical Corporation's Los Angeles district. Formerly senior technical salesman in Los Angeles, Campbell replaces **J. E. Toevs**, recently appointed sales manager of the company's new Synthetic Rubber Sales division. Campbell, who joined Shell Chemical in 1947 as a technologist, was named senior technical salesman in the Marketing-Distribution department last year.

Campbell

Harold J. Egan, director of Can-Amer Oil Sands Development, Ltd., has been elected to succeed **Stanley M. Paulson** as president. Paulson will continue as a member of the board.

William H. Schuette, assistant to the general manager of The Dow Chemical Company's Midland division since early this year, has been appointed to the general manager's post. He replaces **Dr. Mark E. Putnam**, executive vice president who will devote his attention to administrative affairs on a company-wide basis.

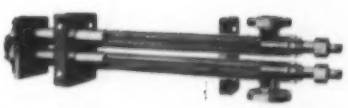
Dr. Schuette had been plastics production manager for three years prior to his appointment as assistant to the general manager. Starting with the company in 1941, he moved to styrene monomer production and in the succeeding years was associated with plastic production. He was assistant production manager of Styron three years when he was named to head

They're all repeat orders for G-R Twin G-Fin Sections

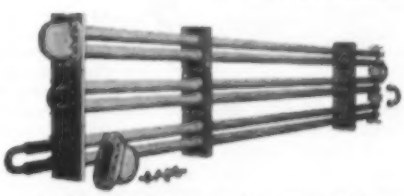
Re-orders — the ultimate proof of satisfactory service — run into the hundreds for many, many purchasers of G-R Twin G-Fin Sections.

Users have re-ordered and **continue to re-order** these units because of the uniformly top-notch performance of each successive installation. In many instances, they have re-ordered and **continue to re-order** to extend the application of these many-purpose heat exchangers to services throughout their plants. Customers all over the country have re-ordered year after year for ten, fifteen years and more, running up the astonishing total of more than 70,000 installed Twin G-Fin Sections during the course of the 25 years since Griscom-Russell originated this design of heat transfer apparatus.

Write for Bulletin 1400 describing the G-R Twin G-Fin Section in detail.



Sectional view of the G-R Twin G-Fin Section



Stack of G-R Twin G-Fin Sections partially dismantled to show ready accessibility of the longitudinally finned heat transfer elements

G-R HEAT TRANSFER APPARATUS

THE GRISCOM-RUSSELL CO.
MASSILLON, OHIO
A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

GR-547

Twin G-Fin Section

What's Happening. . .

plastics production in 1952. In addition to his duties with the parent company, Dr. Schuette is a director of Distrene, Ltd., an English plastics operation formed between Dow and Distillers, Ltd.

William Naden has been elected executive vice president of Esso Standard Oil Company to succeed **Marion W. Boyer** who was named a director of the parent Standard Oil Company (New Jersey). Naden, who has been a director of Esso Standard since 1946 and a vice president since 1950, joined the company 28 years ago as a chemist at the Everett, Mass., refinery.

Margaret H. Hutchinson, chemical engineering consultant for Stone and Webster Engineering Corporation, has received an award for "meritorious contribution to engineering." The award was presented by the Society of Women Engineers. One of the few women active in design work in the petrochemical industry, Dr. Hutchinson handles problems in fractionating-column design, sieve trays and abnormal operating requirements.

She conducted some of the original investigations of the effect of liquid flow on bubble-tray capacity and with co-workers prepared the first paper on the subject which was delivered before the ACS's Petroleum section. During the war, she was assigned to various defense projects and performed work in connection with alkylation units, gas and penicillin plants and butadiene facilities.

Fred D. Davis, who was assistant superintendent of The Texas Company's refinery in West Tulsa, Okla., has been transferred to a similar position at the company refinery at Lockport, Ill. **James A. Ruth,** formerly chief engineer at the Texaco refinery at Port Neches, Texas, now holds the same post at West Tulsa.

Harrison T. Brundage has joined the PETROLEUM REFINER as its editorial representative in New York, where in addition to holding down a job as foreign editor, he will be responsible for keeping up with rapidly-expanding refinery operations on the East Coast. Brundage comes to the REFINER from Corpus Christi, Texas, where he was with the former Sunray Oil Corporation. He also worked for Stanolind Oil and Gas Company for three years. In addition to this experience in Texas, Brundage was stationed for a time in the Appalachian area and also watched the industry nation-wide as an analyst for the Petroleum Administration for Defense.

Brundage

William G. Pulliam, patent counsel for Cities Service Research & Development Company, has been elected vice president. Pulliam joined the Cities Service organization in 1944 as a patent counsel and has been assigned to its research and development affiliate since 1947.

John D. Calfee has been promoted to section leader in Monsanto Chemical Company's Research & Engineering division. Also receiving a promotion in that division is **William R. Richard,** named to section leader. Dr. Calfee, who joined the company in 1950 as a group leader in the Central Research department, will be in charge of certain phases of polymer research now underway at Dayton, Ohio. Dr. Richard, formerly a research chemist, will be a group leader in the same section.

Robert D. Englert has been named director of Stanford Research Institute's laboratory at Pasadena, Calif. His appointment coincides with plans to extend project work into chemistry and chemical engineering. Under his supervision facilities will be expanded and the technical staff increased. With the institute since 1949, Dr. Englert's work there has included research in the nitric-acid process as an intermediate in plasticizers and lubricants. At one time with the University of Colorado's Chemical Foundation Laboratory, he served with the Navy during World War II as a chemist in the Medical Research Institute.

Charles A. Chipman, of Bolivar, N. Y., has been re-elected to his third term as president of Pennsylvania Grade Crude Oil Association. Other officers re-elected at an annual meeting of the board of directors: **George J. Hanks,** chairman of South Penn Oil Company, first vice president; **A. C. Simmons,** Simmons Oil Company, second vice president; **Fayette B. Dow,** Washington, D. C., vice president and general counsel. Also, **Samuel Messer,** Quaker State Refining Corporation, treasurer; **F. W. Alcorn** and **C. L. Suhr,** both of The Pennzoil Company, and **C. G. Johnson,** of Quaker State Refining, all assistant treasurers, and **W. C. Wenzel,** executive manager.

Roland H. Harrison is one of three additions to Esso Laboratories' technical personnel at Baton Rouge, La. The others are **Duane W. Pugh** and **Barry M. O'Brien.**

L. R. Strawn, named manager of the Manufacturing division, is one of seven receiving new appointments in the Operations department of Jefferson Chemical Company, Inc. Others appointed as managers of divisions were **P. R. Monaghan,** Technical Service; **Dr. N. A. Agapetus,** Distribution; and **Dr. L. G. Boatwright,** Market Development. **M. H. Holmes** was made manager of the company's Neches, Texas, plant, and **J. J. Glover** was appointed assistant to the vice president in charge of operations.

C. B. Heartwell has been appointed superintendent of Standard Oil Company's Gas and Natural Gasoline division for the Southern district. He succeeds **G. C. McLaren** who retired after more than 38 years with the company.

Thomas F. McGarey has been elected vice president in charge of the Asphalt division of Cities Service Oil Company. Formerly regional manager in Philadelphia, he has been replaced by **John El Garely, Jr.,** former division manager in New York. For the balance of this year, McGarey will divide his time between

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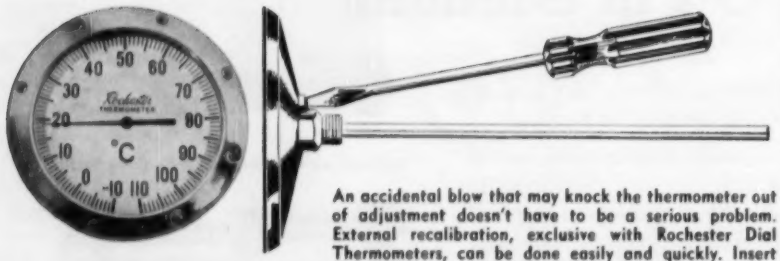

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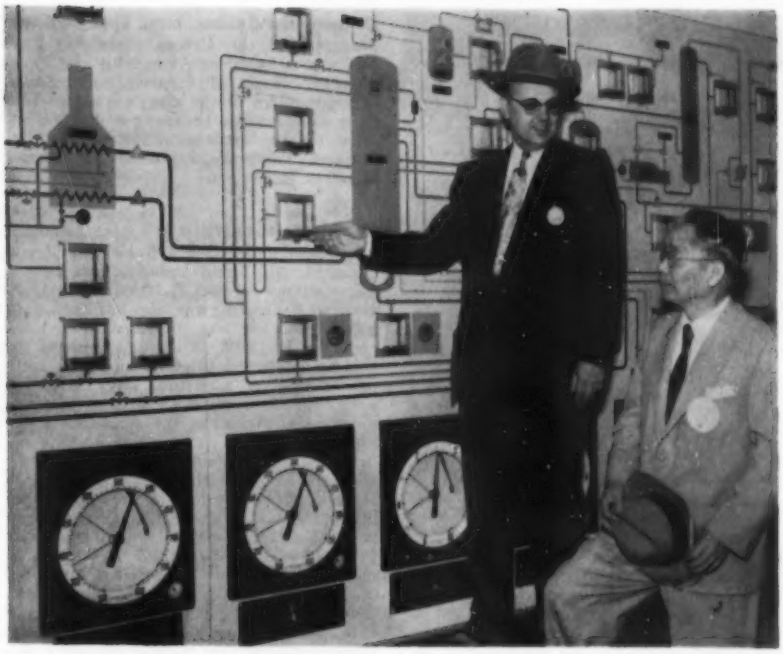

Japanese Executive Tours U. S. Refinery—

L. E. Cranston (left), assistant general manager of the Paulsboro, N. J., refinery of Socony Mobil Oil Company, Inc., shows control panel on one of refinery's crude distillation units to Nobuhei Nakahara, president of Toa Nenryo Kogyo Co., Ltd., Japanese affiliate of Standard-Vacuum Oil Company. Mr. Nakahara visited the Paulsboro plant recently in the course of a world tour. Socony Mobil is half-owner of Standard-Vacuum.

What's Happening. . .

New York and Philadelphia, meanwhile continuing as district chairman of the Oil Industry Information Committee.

George T. Plunkett, for the past several years with American Cyanamid Company in its Internal Audit department, has been elected secretary of Jefferson Chemical Company, Inc. Also named to an executive position was **Edgar H. Bohle,** appointed as assistant to the president. Bohle has been associated with Jefferson Chemical since 1946. The company is owned jointly by American Cyanamid and The Texas Company.

J. W. Hopkinson, president of Penn-Petroleum Corporation, Detroit, has been elected president of the American Society of Lubrication Engineers.

Ju Chin Chu has been appointed professor of chemical engineering at Polytechnic Institute of Brooklyn. Advanced from the rank of an associate professor, Dr. Chu previously was a chemical engineer with Shell Chemical Company and had been a member of the chemical engineering faculty at Washington University.

Ray Powell has been named assistant to the senior vice president of The Texas Company. Powell had been supervisor of process engineering in the company's Refining department since 1944. He joined Texaco in 1931 and before receiving an

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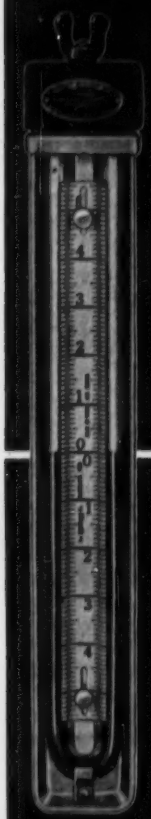

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What's Happening. . .

assignment to its New York headquarters, served the company in the terminals at Bayonne, N. J., and Providence, R. I., and the refineries at Port Arthur, Texas, and Lawrenceville, Ill.

Argus

Brown

R. L. Argus, who was superintendent of construction and maintenance at Pan-Am Southern Corporation's Destrehan, La., refinery, has been advanced to assistant plant manager. **John M. Brown,** formerly operations manager, was promoted to assistant manager of the refinery at El Dorado, Ark.

Brown, who joined the company as a stillman in 1925, was named assistant superintendent in 1929 and in 1951 was assigned to his recent position as operations manager. Argus, with the company 22 years, started as a laboratory sampler.

Daniel L. Hussey, who has returned to the U. S. after a temporary assignment in Iran as general manager of the Abadan refinery, has been appointed an assistant general manager of Esso Standard Oil Company's East Coast Manufacturing division. Another assistant general manager, **D. L. Ferguson,** continues in that position. Hussey, who was general superintendent at the Bayway refinery, went to Iran in September 1954, as head of a survey party to enlarge refinery operations there and in October, became general refinery manager and a member of the board of Iranian Oil Refining Company.

Hussey

Philip A. Nolan has been named chief chemist for Great Northern Oil Company. He will head all laboratory, quality control and testing at the company's 25,000-barrel-a-day refinery scheduled to go on stream next month at Pine Bend, Minn. Nolan formerly was chemical engineer in charge of transfer and storage operations at the Farmers Union Central Exchange refinery in Laurel, Mont.

Ray Althouse, formerly executive vice president of Royalite Oil Company, Ltd., has succeeded **C. E. Daniels** as president. Daniels, who was named chairman of the board, will continue as the Canadian company's chief advisory officer.

Duane Davis has been appointed coordinator of the Creole Petroleum Corporation refinery at Amuay on the Paraguana Peninsula. He formerly was assistant superintendent of the company's San Joaquin district. Also receiving a new assignment at the Venezuelan refinery is **Hippolyte C. Lawrence,** appointed temporarily as safety supervisor.

Herbert Rothstein has been elected a vice president of Bell Oil and Gas Company. He will be succeeded as secretary of the company by **Joel P. Dyer,** formerly its auditor. Rothstein, who also has been serving as assistant vice president, joined the company in 1939. In his new position, he will be concerned primarily with the company's refining activities. Dyer, who has been with Bell since 1931, also is office manager and chief of the Accounting section.

Other changes in the company's organization include the promotion of **E. S. Horner,** superintendent of the Ben Franklin refinery at Ardmore, Okla., to manager of refining. The new assignment gives Horner, who will continue in charge of the Ardmore plant, supervision also over the refinery operations at Grandfield, Okla. He will be assisted at Ardmore by **L. K. Buchanan,** who was named associate superintendent, and Russell Davidson, appoined chemical engineer.

S. H. Hastings has been advanced to research specialist in the Research and Development division at Humble Oil & Refining Company's Baytown, Texas, refinery. Also receiving a promotion at the Baytown refinery is **J. C. Weisinger** who

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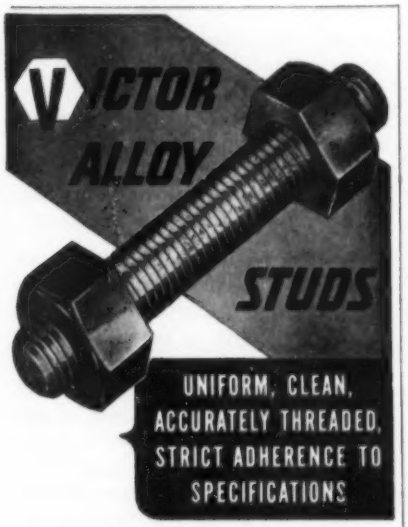
was appointed a mechanical engineer in the Engineering division's Design department. Weisinger is a mechanical engineering graduate from Texas A&M College. Dr. Hastings completed his advanced degrees at the University of Texas. He will specialize in physical analytical methods with particular emphasis on higher boiling petroleum fractions.

Fred D. Fagg, Jr., president of the University of Southern California, has been elected a director of Union Oil Company of California. Dr. Fagg fills the vacancy created by the recent death of Gurney Newlin.

Rex E. Lidov has been appointed research associate in the Research department of Brea Chemicals, Inc. Formerly assistant manager of Shell Development Company's Agricultural Chemicals division in Denver, Dr. Lidov will participate in new product development with the Union Oil Company of California subsidiary.

Lidov

He has served as research chemist for Portland Gas and Coke Company and Dearborn Chemical Company, and before joining the Shell organization, he was an assistant research director for Velsical Corporation and director of research with Julius Hyman and Company.



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Build Texas Refinery—

Officers of the recently-organized North American Petroleum Corporation, now clearing ground to build a refinery at Corpus Christi, Texas, are (left to right) Floyd D. Hall, vice president; Victor VerMilyea, president, and Jack Gaines, vice president, secretary and treasurer. VerMilyea, one time purchasing and transportation head for La Gloria Corporation, also has been connected with United Refining Company and Ashland Oil and Refining Company. Hall formerly was a project manager for The Lummus Company.

B. Brewster Jennings, president of Socony Mobil Oil Company, Inc., since 1944, has been elected chairman of the board, succeeding George V. Holton, who retired. Named to replace Jennings as president was Albert L. Nickerson, formerly vice president and director in charge of the company's foreign trade. In addition to choosing a new chairman and president, the company picked two new directors. They are Austin T. Foster and Paul V. Keyser, Jr.

Jennings, a director of the company since 1939, will remain chief executive officer and chairman of the executive committee. He has been with the company since 1920. Nickerson, who started with the company as a service station attendant in 1933, was elected to the board in 1946 and given charge of the company's foreign trade operations in 1951. He was elected a vice president at that time.

Foster has been general counsel for Socony Mobil since 1948. He joined the company 20 years earlier after four years in banking and an equal period with a law firm. Keyser started at the company's Brooklyn laboratories in 1930 and was named manager there in 1938. He was engaged with technical assignments until 1951 when he was given marketing responsibilities.

Deaths—

Lindsay Hanna, retired vice president and director of Standard Oil Company of California, died May 28 following an extended illness. Hanna, who retired in 1948 after 37 years with the company, joined Standard during construction of its El Segundo, Calif., refinery in 1911, and later became superintendent of the refinery at Bakersfield, Calif.

Howard R. Huston, retired vice president and director of American Cyanamid Company, died June 8 at his home in Truro, Mass.

What's Happening. . .

R. W. Gerhard has been appointed director of the coordination division in the distribution economics department of Standard Oil Company (Indiana). Gerhard has been supervisor of cost control in general office of the manufacturing department. He joined the company in 1944 as a chemical engineer at its Wood River, Ill., refinery.

T. S. Petersen, president of Standard Oil Company of California, has accepted President Eisenhower's request that he serve as business representative on the President's Action Committee for Traffic Safety.

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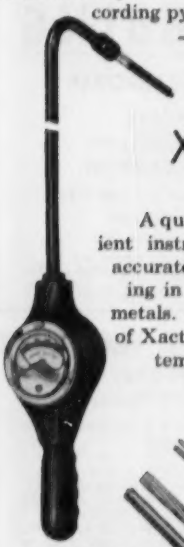

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Who's Meeting . . .

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. . . **Further development** of the gas turbine for marine and industrial users depends to a large extent on its ability to use residual-type fuels at higher temperatures. The problem to be faced is the effect of fuel oil ash constituents on high temperature deposition and corrosion. Experimental work in the temperature range of 1300-1600 F shows great promise for a number of additives—magnesium, zinc, phosphorus and calcium compounds. Magnesium acetate (one of the best), injected into the fuel line before the high pressure pump, eliminated corrosion and did not increase the deposits above the original level of the fuel oil without additive. By using an aqueous solution in this manner, good distribution of the additive was obtained (E. B. Evans, D. H. McLean, F. R. P. Sharp, and A. Winward, Esso Development Co., Ltd., Abingdon, Berkshire, England).

. . . **Looking to 1968,** European spokesmen see a widening gap between available coal and hydroelectric power and the demand for energy in the O. E. E. C. countries. Unless new sources of energy such as atomic energy can play a significant role, only fuel oils can fill the gap. Current fuel oil prices make it possible for the consumer to expand their use of fuel oils to a considerable extent. As the Middle East appears to have sufficient crude oil reserves to cope with the increased supply which the larger-scale use of fuel oils would involve, the problem is one of refinery economics (P. H. Frankel) . . .

. . . **But American observers** see a decrease in residual fuel use in Europe (percentagewise). They see a change in the pattern of European fuel use towards higher percentages of gasoline and distillate fuel. They expect refineries in Europe to follow the same trend now present in U. S.—increased catalytic cracking operations, extensive use of diesel and distillate heating oil containing cat cracked stocks, and increased catalytic reforming operations (W. M. Holaday and R. E. Albright, Socony Mobil Oil Company, New York) . . .

. . . **Recent automotive** testing indicates that the Research octane is becoming a less accurate prediction of actual road performance. More important, maximum aromatic production is probably not the best path to optimum gasoline quality. Development is now being focused on achieving greater yields of higher octane isoparaffins with enough aromatic production to provide the hydrogen required. The Catforming process may be adapted to the isomerization of n-pentane to iso-pentane (M. J. Fowle, R. D. Bent, and B. E. Milner, Atlantic Refining Company, Philadelphia). . .

. . . **Air pollution** occupies the attention of European refineries probably even more than U. S. refineries. The Esso refinery in the United Kingdom took the following steps in the basic refinery design to minimize pollution: 1) preferential use of gas for furnaces and provision of cyclones to remove solid particles from effluent gases; 2) design and operation of furnaces and stacks to prevent smoke; 3) exclusion of sulfuric acid treatment to minimize sulfurous fumes; 3) measures to prevent crude or refined products from releasing fumes to the atmosphere; 4) provision of a deodorizer for treatment of spent caustic soda streams; 5) provision of a sulfur recovery plant to reduce sulfur compounds expelled (I. McCallum, P. G. Layzell and R. A. Vere, Esso Petroleum Company, Ltd., Fawley, England).

* World Petroleum Congress, Rome, Italy, June 6-15.

For more data on advertised products, use Readers' Service Cards, last page.

MEETINGS CALENDAR

AUG.	
15–17	Society of Automotive Engineers (West Coast Meeting), Hotel Multnomah, Portland, Ore.
15–19	American Institute of Electrical Engineers (Pacific General Meeting), Butte, Mont.
SEPT.	
12–14	American Institute of Electrical Engineers (Electrical Conference of the Petroleum Industry), Shamrock Hotel, Houston.
12–16	Instrument Society of America (Annual Conference and Exhibit), Shrine Auditorium, Los Angeles.
12–16	American Institute of Electrical Engineers (Instrument Conference), Shrine Auditorium, Los Angeles.
14–16	National Petroleum Association (Annual Meeting), Traymore Hotel, Atlantic City, N.J.
22–23	Western Petroleum Refiners Association (Regional Technical-Industrial Relations Meeting), Hotel Henning, Casper, Wyo.
22–23	Mid-Continental Oil & Gas Association, Louisiana-Arkansas Division (Annual Meeting), Roosevelt Hotel, New Orleans.
25–28	American Institute of Chemical Engineers, Lake Placid Club, Lake Placid, N.Y.
25–28	American Society of Mechanical Engineers (1955 Petroleum Mechanical Engineering Conference), Roosevelt Hotel, New Orleans.
25–28	American Institute of Chemical Engineers, Lake Placid Club, Lake Placid, N.Y.
29	Natural Gasoline Association of America, (Oklahoma Regional Meeting), Skirvin Hotel, Oklahoma City.
OCT.	
2– 6	American Society for Testing Materials Committee D-2, Petroleum Products and Lubricants, Statler Hotel, Washington, D.C.
3– 7	American Institute of Electrical Engineers (Fall General Meeting), Morrison Hotel, Chicago.
10–12	American Society of Mechanical Engineers, Lubrication Activities Committee, and American Society of Lubrication Engineers (Joint Lubrication Conference), Antlers Hotel, Indianapolis, Ind.
12–14	National Association of Corrosion Engineers, Permian Basin Section, (Biennial Permian Basin Corrosion Tour), Headquarters at Lincoln Hotel, Odessa, Texas.
13–14	California Natural Gasoline Association (Annual Fall Meeting), Ambassador Hotel, Los Angeles.
17–19	American Gas Association (Annual Convention), Los Angeles.
18–20	American Institute of Electrical Engineers (Motor Applications and Problems in Heating and Cooling Conference), St. Louis.
18–22	National Safety Congress & Exposition, Sponsored by National Safety Council, Chicago.
20–21	Western Petroleum Refiners Association (Regional Technical-Industrial Relations Meeting, Garrett Hotel, El Dorado, Ark.
24–26	American Standards Association (Annual Meeting), Sheraton Park Hotel, Washington, D.C.
27–29	Rocky Mountain Oil & Gas Association (Annual Convention), Cosmopolitan Hotel, Denver, Colo.
28	Natural Gasoline Association of America (Southern Regional Meeting), Captain Shreve Hotel, Shreveport, Louisiana.
31–Nov. 2	Society of Automotive Engineers (Transportation Meeting), Chase Hotel, St. Louis, Mo.
31–Nov. 2	National Lubricating Grease Institute (Annual Meeting), Edgewater Beach Hotel, Chicago.
NOV.	
9–10	Society of Automotive Engineers (Fuels and Lubricants Meeting), Bellevue-Stratford Hotel, Philadelphia, Pa.
13–18	American Society of Mechanical Engineers (Annual Meeting), Hilton and Blackstone Hotels, Chicago, Ill.
14–17	American Petroleum Institute (Annual Meeting), Mark Hopkins, Fairmont, St. Francis and Palace Hotels, San Francisco.
27–30	American Institute of Chemical Engineers (Annual Meeting), Statler Hotel, Detroit.

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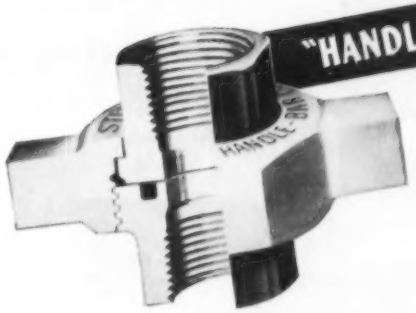

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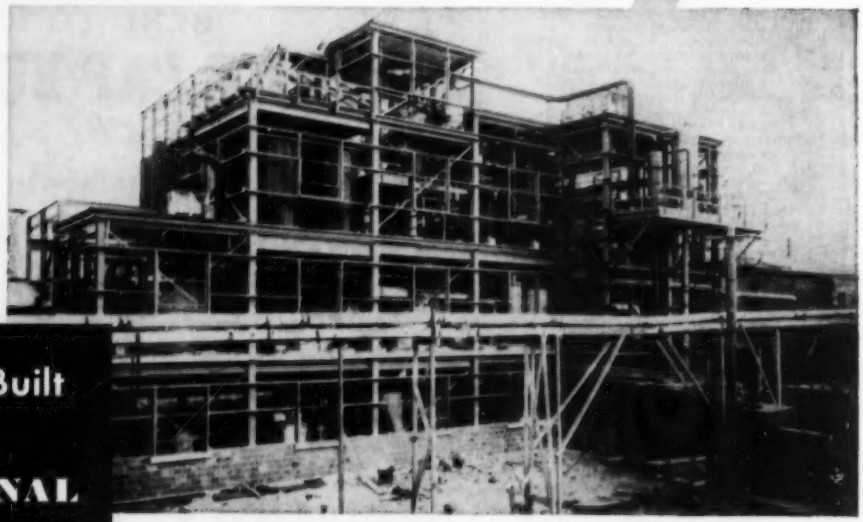

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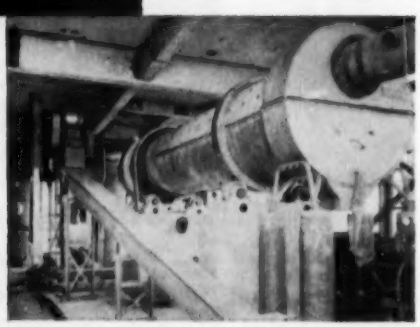

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What Suppliers Are Doing . . .

Hutchinson McLaughlin Emerson Kline Black Porter Crawshaw Sherwood Jones

John M. S. Hutchinson, formerly works manager of the body and car-building assembly of the Chrysler division of Chrysler Corporation, is the newly-elected vice president and assistant to the president of **The Perkin-Elmer Corporation.**

William R. McLaughlin, Southwestern regional sales manager for **Rockwell Manufacturing Company's** Meter & Valve division, has received a scroll from the Executive Committee of the Southwestern Gas Measurement Short Course at the University of Oklahoma for 32 years' service to the course.

James L. Emerson has been named to a newly-created post as assistant to the manager of **Chiksan Company's** Sales Development department. Formerly advertising manager for The George S. Thompson Corporation, he will devote most of his time to Chiksan's advertising and sales-promotion program.

Charles H. Kline, formerly manager of chemical sales and development for **Climax Molybdenum Company**, has been selected as manager of the company's new Chemical Development division.

Robert F. Black has been elected to a new position as chairman of the board of **The White Motor Company.** He also was re-elected as president and chief executive officer.

Edward D. Porter, with **Norton Company's** Research & Development department since 1948, is manager of the new electric furnace plant the company is building at Huntsville, Ala. **J. Zach Higgs**, who was superintendent at the Norton bauxite plant at Bauxite, Ark., was named superintendent of the Alabama facility.

S. L. Crawshaw, president of the American Gear Manufacturers Association, has joined **Philadelphia Gear Works, Inc.**, as assistant to the president. He is author of the Gearing section of Kent's Mechanical Engineers Handbook.

Robert S. Sherwood, until recently with the Mechanical Engineering department at Iowa State College and one time consultant to **Worthington Corporation**, has returned to that company as assistant director of research. He also will handle administrative duties in connection with Worthington patents.

Watson Funk Morrisey Andrews De Groote Esty Edick Moore Oweiss

C. R. Jones has been promoted to manager of western Canada for Cooper-Bessemer of Canada, Ltd. He was replaced as branch manager for **The Cooper-Bessemer Corporation** in Seattle by **John McKissick**, with the company since 1941 in sales assignments at San Francisco and Seattle.

Ralph M. Watson will leave **Worthington Corporation** to become associate dean of L. C. Smith College of Engineering and chairman of the Department of Mechanical Engineering at Syracuse University. He will be replaced as director of research by **Hellmuth Walter**, a German engineer who came to the U. S. in 1950 as a consultant to Worthington.

William R. Funk, Jr., with **Walter L. Benson**, in business together as Benson, Funk & Associates, have been selected as engineering and sales representatives for **Brown Fintube Company** in New England.

William R. Morrisey has been appointed sales representative for **Wolverine Tube**, Division of Calumet & Hecla, Inc., for Chicago and the surrounding areas. Formerly with American Manganese Steel, Division of American Brake Shoe Company, he will handle aluminum and steel accounts.

Robert C. Andrews has been appointed sales manager for **Clark Equipment Company's** Axle division. For the past 15 years with Vickers, Inc., Andrews will be in charge of the Axle division's sales activities, including sale and dealer organization. He will headquarter in Buchanan, Mich.

Melvin De Groote, vice president of Tretolite Company Division of **Petrolite Corporation**, has received the degree of Doctor of Science from Ohio State University. The honor was conferred at the spring commencement ceremonies. Dr. De Groote holds some 750 patents, either as sole or joint inventor.

F. B. Esty, assistant chief engineer of **Wisconsin Motor Corporation** since 1948, has been advanced to chief engineer. He was named to succeed A. F. Milbrath, recently deceased.

George W. Edick has been promoted to New York City branch manager of compressor and stationary engine sales for **The Cooper-Bessemer Corporation.** Edick joined the company in 1945 and has been assigned to the New York office since 1949.

Richard S. Moore has been made general sales manager of **Harbison-Walker Refractories Company.** Assistant general sales manager since 1953 and prior to that manager of basic sales, Moore has been with the company since 1929, serving in various production positions before transferring to the Sales Technical department.

W. A. Oweiss has been appointed West Texas-New Mexico sales engineer for Rockwell-Built Edward Valves, a subsidiary of **Rockwell Manufacturing Company.**

Du Pont Company has chosen Frank B. Stirling as its office supervisor for the Petroleum Chemical division's Western region, headquartered at Los Angeles. He replaces T. Parvin Cook, who retired after

Suppliers . . .

being with the company since 1933. Formerly supervisor of the Order & Clerical section of the Petroleum Chemicals division in Wilmington, Del., Stirling has been with Du Pont since 1926.

U. S. Steel Corporation has appointed **Harold W. Scott** as field representative at Avenal, Calif., for the company's Oil Well Supply division. Others receiving new appointments in the Oilwell organization include **Wilburn D. Lakey**, named representative at Beaumont, Texas, and **James G. Harvey** and **William R. Mayes**, both selected as division representatives at Graham, Texas.

Carbide & Carbon Chemicals Company has appointed two new assistant district sales managers. They are **M. W. Duncan**, assigned to the company's Kansas City district, and **J. R. Retter**, named to the post for the Detroit district.

Davison Chemical Division of W. R. Grace & Company is building a $4-million plant to manufacture petroleum cracking catalyst at Curtis Bay, Md. The company plans to have its new facilities completed next spring.

Clark Equipment Company has selected Harlan C. McKay Company, a Portland, Ore., firm, to sell and service its automotive products in Idaho, Oregon, Washington, British Columbia and Alaska.

The Timken Roller Bearing Company is the recipient of a citation for the best installation of a materials handling system in northeastern Ohio. The award was made by American Society for Materials Handling at an annual meeting in Cleveland. The award last year went to Ford Motor Company's Cleveland plant.

Climax Molybdenum Company has created three new domestic divisions in its sales organization. The reorganization, undertaken to promote a closer coordination of the company's sales effort and provide a more complete technical service, calls for new divisions to handle direct sales, metallurgical-market development and chemical-market development.

Easton Plastic Products Company, after a year of development work, has swung into full production of rigid plastic pipe at its plant in Easton, Pa. The new plant, the largest in the U. S. producing rigid polyvinyl chloride pipe, employs extruding methods developed in Europe.

The International Nickel Company, Inc., has added Leon M. Petryck to its Development & Research division. He was appointed as a research metallurgist in the Welding section at the company's research laboratory in Bayonne, N. J. The section is being enlarged to expand research in this field.

Phelps Dodge Refining Corporation has elected **Howard Barkell** as a director and **Charles H. Winship, Jr.,** as

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- **Industrial Solvents** by Ibert Mellan — Price $12.00
- **The Physical Chemistry of Lubricating Oils** by A. Bondi — Price $10.00
- **Elements of Fractional Distillation** by C. S. Robinson and E. R. Gilliland — Price $ 7.50
- **The Chemistry of the Non-Benzenoid Hydrocarbons** by Benjamin T. Brooks — Price $12.00
- **Methods of Analysis of Fuels and Oils** by O. H. Bardill — Price $17.00
- **Chemical Engineers' Handbook** by J. R. Campbell and W. Gibb — Price $ 4.00

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vice president. Barkell is a vice president of the refining corporation, and Winship is sales manager of both the refining company and Phelps Dodge Corporation.

Hercules Powder Company has opened a new rubber-chemicals sales office in Beaumont, Texas, to serve the synthetic-rubber industry in the South and West. **Wilfred E. Osberg Jr.**, was named manager of the new office and its sales territory which includes Texas, Louisiana and California.

Worthington Corporation has held a meeting of its West Coast district managers to inspect office and warehouse facilities and to bring the group up to date on the company's procedures and organization. Worthington managers attending the two-day meeting were **P. E. Wilson**, from Salt Lake City; **E. D. Schively**, of Seattle; **P. L. McManus**, of San Francisco, and **J. G. Murphy**, from Los Angeles.

Arthur G. McKee & Company has made an agreement which will permit it to use a number of German chemical processes in plant construction in the U. S., its territories and Canada. The agreement was consumated between the company and The Uhde Corporation, New York subsidiary of Friedrich Uhde, G. m. b. H., of Dortmund, Germany. In addition to ammonia and related nitrogen products, the available processes include production of carbon bisulfide, formaldehyde, methanol, calcium cyanamide, magnesium metal, polystyrene and sulfur recovery.

Suppliers . . .

The M. W. Kellogg Company has produced what is believed to be the first movie ever made showing what happens inside a catalytic cracker. Done in animation, the 16-mm. color film runs 15 minutes and is entitled "The Orthoflow Fluid Catalytic Cracker. The movie describes the various types of catalytic cracking units and how the older types were improved to develop today's units.

Worthington Corporation has selected William J. Davies to succeed Robert J. Laidlaw as manager of the district office in Cleveland. With the company since 1919 and manager in Cleveland for the past 12 years, Laidlaw will retire because of his health. Davies, who has been assigned to the Cleveland office as a sales engineer since 1942, joined the company in 1938.

Davies

Leeds & Northrup Company has promoted a sales field engineer to district manager and changed the territory for another district manager. Earle D. Moiles, Jr., was named to head the district office in Boston, replacing Paul K. Welch, who was transferred to New York as district

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Suppliers . . .

manager there. In taking charge of the New York office, Welch succeeds Harold L. Scutt, who recently was promoted to manager of the Sales Engineering division in Philadelphia.

Crane Company has elected Frank F. Elliott as president and chief executive officer. Senior vice president in charge of sales since 1952, he replaces John L. Holloway, who resigned as president and director because of ill health. Holloway will continue as a consultant to the Company.

U. S. Steel Corporation has completed the steelwork for Gulf Oil Corporation's new package and grease warehouse at Port Arthur, Texas. The work was done by the Consolidated Western Steel division, which also fabricated the steel at Gulf's Orange, Texas, plant. The new warehouse will adjoin Gulf's Port Arthur refinery.

General Electric Company will manufacture two 16,000-kilowatt combustion gas turbine-generator sets for a Mexican industrial firm. The sets, to have a higher rating than any yet manufactured in the Western Hemisphere, will be shipped to Planta Electrica of Groupo Industrial in Monterrey in 1956. The two simple-cycle, single-shaft sets will be installed adjacent to the Hojalata y Lamina steel mill. Natural gas will be used as fuel.

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The Electric Controller & Manufacturing Company has completed a $4,500,000 plant in one of Cleveland's outlying industrial areas. Planned for long-range as well as immediate operating requirements, the plant was built for flexibility in layout of offices and factory. Whole departments can be moved and the production flow altered at a minimum cost. Overhead space, utilities, hoisting facilities, even compressed air is available wherever needed.

Burgess-Manning Company has named H. A. Dietrich as manager of its Libertyville, Ill., division, and F. C. Duerr has been appointed manager of the company's Chicago district. Dietrich was district manager in Chicago, and Duerr was a sales engineer under him.

The Pfaudler Company has appointed Charles M. Fletcher as manager of its Philadelphia regional office, serving eastern Pennsylvania, Delaware and southern New Jersey. Prior to this appointment, Fletcher was sales engineer for the Connecticut area.

Eagle-Picher Company has selected **Pascal M. Rapier** as process engineer at the company's Clark, Nev., plant. He previously was with Great Lakes Carbon Corporation at its Dicalite division in Walteria, Calif., where he supervised new products and process development.

Davison Chemical Company, division of W. R. Grace & Company, has been selected for the annual Award of Merit of the Research Institute of America's Associate Membership division. The award was made for the company's use of plant committees with equal representation for man-

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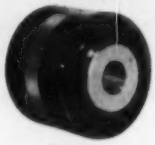

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Davison Chemical Company, Division of W. R. Grace & Company has established a new professorship at The Johns Hopkins University to be known as the "Grace Chair of Chemistry." **Dr. Paul H. Emmett,** with Mellon Institute of Industrial Research in Pittsburgh, accepted an invitation to fill the new post. Dr. Emmett is a former member of the faculty at Johns Hopkins and from 1937 to 1944 was chairman of the Department of Chemical Engineering.

Laclede-Christy Company, Division of H. K. Porter Company, Inc., has transferred **H. Wynn Gethin** from St. Louis to Pittsburgh as district sales manager. Gethin joined the company in 1944 and had been manager of the St. Louis district since 1951.

Worthington Corporation will market centrifugal pumps manufactured by National Carbon Corporation, a division of Union Carbide & Carbon Corporation. The distribution will cover motor-mounted and frame-mounted units with capacities ranging from 5 to 1500 GPM at heads to 110 feet at conventional motor speeds.

Sarco Company, Inc., has chosen two new sales representatives. They are J. B. Lammons Company, which will serve the Memphis, Tenn., area, and Robert Porter, who is stationed in Jackson, Miss.

Suppliers . . .

McBride Bugg Anderson

B-I-F Industries has expanded its sales and service facilities in the Chicago area with the formation of two new offices under M. H. Strickland, recently named industrial sales manager for that district. A new office in Milwaukee is headed by Harold D. Bugg, while another new office in Indianapolis is managed by Byron Anderson. Harry McBride, with the company six years, has joined the Kansas City sales force.

Wolverine Tube, Division of Calumet & Hecla, Inc., has appointed **Dr. Donald Q. Kern** as professional consultant in heat transfer. Dr. Kern has served as design engineer for several of the leading manufacturers of heat-transfer equipment, including Foster Wheeler Corporation and Patterson Foundry & Machine Company.

Roots-Connerville Blower, Division of Dresser Industries, Inc., is establishing

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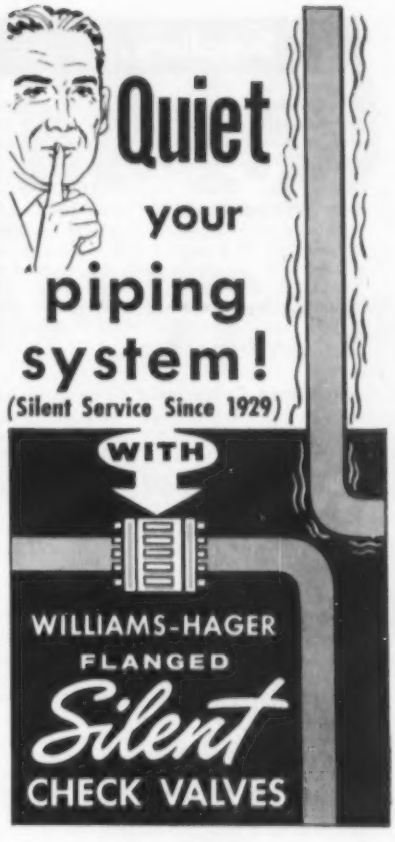

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Suppliers . . .

a new sales office in Detroit. **D. A. Johann,** with the company at its Chicago office for the past five years, was assigned to manage the Detroit sales territory.

Gar Wood Industries, Inc., has created a new Chemical Structure division, appointing W. Russell Bailey as its director of research. Recently with the Bureau of Standards as a general experimental engineer, Bailey also has been connected with Allied Plastics Corporation, a Washington, D. C., consulting firm.

American Cyanamid Company has engaged Dr. William H. Bowman as assistant general manager of its Organic Chemicals divisions. He had been associated with Jefferson Chemical Company, Inc., for the past ten years and been a vice president of that company since 1951. Jefferson Chemical is owned jointly by American Cyanamid and The Texas Company.

Union Carbide and Carbon Corporation has elected Howard S. Bunn as its executive vice president. With the company since 1922, Bunn has served as manager of its Pyrofax Gas division, head of the Plastics division for Carbide and Carbon Chemicals Company, and successively vice president of Carbide and Carbon and vice president and president of Bakelite Company. He was elected a vice president of Union Carbide and Carbon in 1953 and last year was made a director.

Fluor Board Meets in Houston—

The board of directors of The Fluor Corporation, Ltd., recently met at the company's Mid-Continent Engineering division headquarters in Houston. This was the first in a series of board meetings scheduled at Fluor's major engineering offices away from Los Angeles. The directors are (left to right) James P. Wiseman, Donald Royce, J. R. Fluor, J. S. Fluor, F. E. Fischer, F. S. Wade, F. G. Breyer and J. Oostermeyer. D. W. Darnell, chairman, and S. W. Andrews were unable to attend.

Norton Company has appointed Robert M. Scott as refractories engineer for the Cincinnati, Ohio, area. He succeeds Gerald H. Lusher who has been made engineer for a new sales territory covering West Coast industrial centers. Scott, with the company since 1953, had been serving in the Sales Engineering department. Lusher was an assistant ceramic engineer with Basic Refractories, Inc., before he joined Norton in 1951.

Dunton Processes, Inc., has selected Paul S. Cooper as its representative to serve industries in Connecticut, Massachusetts, Rhode Island, Vermont, New Hampshire and Maine. Cooper, who headquarters in Westport, Conn., will handle a complete line of the company's equipment.

Stauffer Chemical Company has appointed Philip McLaughlin as assistant sales development manager. In addition to sales development work, he will assist in technical services. McLaughlin is to be stationed at the company's New York office.

Sarco Company, Inc., has selected two new sales representatives. They are C. H. McGuiness Company, which will cover the Des Moines, Iowa, area, and Steam Engineering Service Company, which will work out of Denver.

Carlisle Chemical Works, Inc., has acquired Advance Solvents & Chemical Company, together with its subsidiaries.

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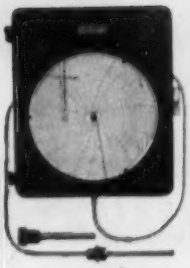

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The transaction gives Carlisle further expansion in the field of chemical additives and Advance gains access to Carlisle's manufacturing and research facilities.

Atlas Powder Company has appointed Thomas H. Sadler as a petroleum engineer in its Central Research Laboratory. Sadler formerly was with John I. Thompson and Company in Bellefonte, Pa., as an engineer.

Wolverine Tube, Division of Calumet & Hecla, Inc., has moved the sales manager of its East Central district to Detroit. J. H. Smith, formerly stationed in Dayton, Ohio, transferred to the new Detroit branch office which will become district headquarters. Replacing Smith in Detroit is R. B. Flynn who will become territorial supervisor, in charge of sales offices at Columbus, Ohio, and Louisville, Ky.

Crane Company has selected George G. Lindholm to serve as manager of its Valve and Fitting department at the general office in Chicago. Manager of the Chicago branch office since 1948, he succeeds F. J. Wilkey who was named special representative to the company's Industrial Sales division. Wilkey had headed the department since 1944.

The Carpenter Steel Corporation's Alloy Tube division has moved its Eastern regional sales office from the home office at Union, N. J. The division's regional operations formerly were headquartered in Newark.

Dow Chemical International, Ltd., is opening a new Far Eastern sales office in Tokyo. The new branch will serve the entire Far Eastern area including Japan, Hong Kong, the Philippines, India and Taiwan. It also will serve Australia and New Zealand. H. Lee Clark, recently manager of Dow Chemical Inter-American's branch office in Uruguay, was appointed manager of the Tokyo office. His assistant will be Howard C. Visgar, formerly Far Eastern area supervisor in the company's Midland, Mich., export headquarters.

The International Nickel Company, Inc., has added C. Roger Sutton to the staff of its Research and Development division. A senior metallurgist at the AEC's Argonne National Laboratory for the past five years, Sutton has been assigned to Inco's Stainless Steel and Heat Resistant Alloys section. Prior to his appointment to the governmental laboratory, he served five years as a general consultant.

Ethyl Corporation, in a series of promotions, made four new sales assignments. Ellis K. Locher, who has been serving as district manager in Los Angeles, was named assistant manager for the company's Central region, headquartered in Chicago. His promotion follows the appointment of Stuart Forbes as Central region manager. T. S. DuBose was named Los Angeles district manager, and Douglas Jeppe, Sr., who had been account representative in Okla-

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AUTOMATICALLY
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AUTOMATIC
PLUG VALVE LUBRICATOR

Engineers agree that plug valves should be lubricated each time they are opened and closed.

NOW they can be—automatically—by the adaption of this simple, fool-proof device, that never forgets.

Each time the valve is opened and closed a measured amount of lubricant is forced in. The reservoir holds enough lubricant for the valve to be opened 50 to 80 times, and is refilled in seconds with the Delta Gun.

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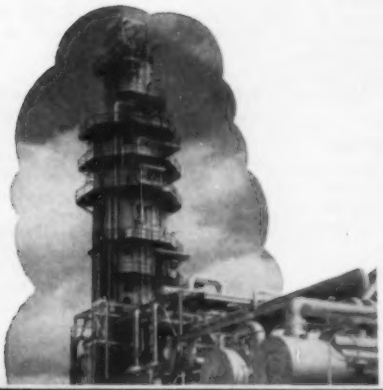
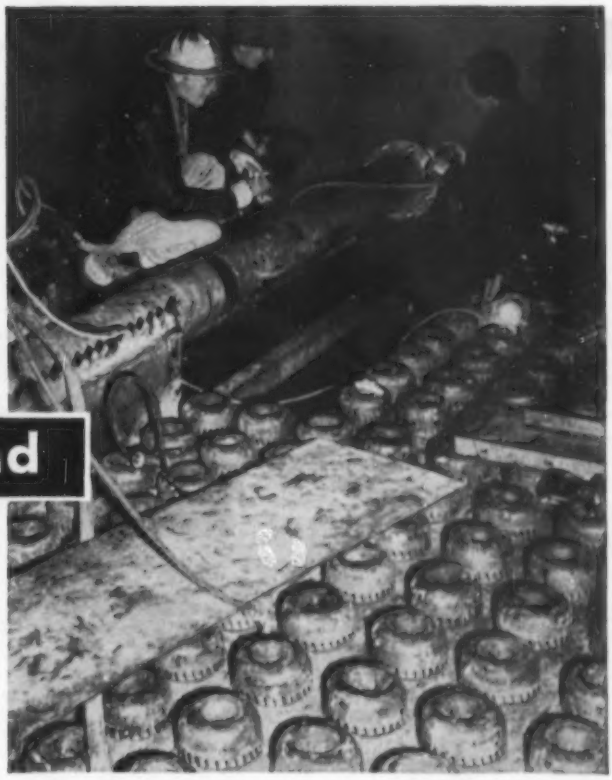


At Fawley, England



Monel gives Esso a high level of performance in fractionating tower tops

Fitting Monel internals in Monel-Clad top of fractionating tower. Top sections of fractionating towers are protected from corrosion by Monel cladding. In this area, distributor pipes, trays, bubble caps and fittings are solid Monel.

About two years ago, the two distillation units in Esso's Fawley refinery went on stream. Designed by Standard Oil Development Company and constructed by Foster Wheeler, Ltd., it is the largest refinery ever built at one time anywhere.

One unit is a single-stage atmospheric tower. The other is a two-stage atmospheric and vacuum unit. Both use Monel® in the top sections . . . Monel trays, Monel bubble caps, Monel pipe, Monel-Clad linings.

When examined after the first year, the Monel in the single-stage unit was still in "as new" condition. Today, both atmospheric towers are breaking down corrosive crudes originating in Arabia, Iraq, and other sections of the Middle East.

Reasons for choosing Monel

For one thing, Monel costs less per pound than other alloys able to withstand the corrosion. Furthermore, it requires no heat treatment since its corrosion resistance is not impaired by welding. Then, too, Monel is easy to form . . . lends itself well to lining.

But the most important reason for choosing Monel is the way it stands up to the various corrosives found in upper sections of fractionators.

In this area, reflux pushes vapor temperatures down to about 250°F. Walls and trays cool vapors further. As they go below the dew point, aqueous hydrochloric and sulfuric acids form in the condensate. Corrosive salt compounds may be present also.

The record of Monel in resisting all these forms of corrosion when temperatures are under 500°F., is outstanding . . . not only in atmospheric towers, but in overhead condensers, too.

If your next inspection of either type of equipment shows corrosion, why not investigate the use of Monel? A letter addressed to Inco's Corrosion Engineering Section will bring full information regarding the application of Monel in this corrosive service. No cost or obligation, of course.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

INCO Nickel Alloys

Monel...for minimum maintenance

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

homa City was named to succeed DuBose as district manager in New Orleans. Kerney J. Hurst, formerly a field engineer at Little Rock, Ark., was transferred to Oklahoma City to replace Jeppe.

U. S. Steel Corporation crews have completed the steelwork for Gulf Oil Corporation's new package and grease warehouse in Port Arthur, Texas. The installation, covering some eight acres, required more than 1300 tons of steel. The company's Consolidated Western Steel division, which handled the project, also fabricated steel at Gulf's plant in Orange, Texas.

J. F. Pritchard and Company has selected The C. J. Gaskell Company, Inc., a Memphis, Tenn., firm, as its sales representative for western Tennessee, southwestern Kentucky, northern Mississippi, northeastern Arkansas and southeastern Missouri.

The Perkin-Elmer Corporation has established a subsidiary Nuclear Magnetics Corporation, to market a line of nuclear magnetic resonance equipment. Manufacturing operations will be carried out at the parent company's plant in Norwalk, Conn.

U. S. Rubber Company has elected G. Allen Lovell as vice president, appointing him also to serve as general manager of its Mechanical Goods division. With the company since 1918, Lovell was appointed assistant general manager of the division last November.

Allis-Chalmers Manufacturing Company has realigned its operating divisions, setting up six major divisions to carry out operations. Of the six divisions, each to be headed by a general manager, three will be in the company's industries groups, formerly known as the General Machinery division, and three will be in the Tractor group, once called the Tractor division. J. L. Singelton will head the Industries group, and W. G. Scholl will be in charge of the Tractor group. Both are vice presidents and directors of the company.

H. K. Porter Company, Inc., has bought The Vulcan Crucible Steel Company. The Pittsburgh manufacturer of tool steel becomes the twelfth Porter division. The company has branch offices in Chicago, Detroit and Boston, together with sales representatives stationed in New York, Baltimore, St. Louis and Lansing, Mich.

Laclede-Christy Company has advanced O. A. Olson to assistant director of research. With the company 17 years, Olson was serving as a project engineer when promoted to his new position. The company is a division of H. K. Porter Company, Inc.

American Machine and Metals, Inc., in the first of a series of appointments to expand the sales organization for its Niagara Filters division, named John M. McConney as assistant appliance engineer. He formerly was connected with Merck & Company as a research and development engineer.

Selas Corporation of America has started construction on a $1-million main office and plant at Dresher, Pa. Operations at the new facilities will be in addition to manufacturing carried on at the company's existing plant in Philadelphia. This unit was completely modernized some three years ago.

American Cyanamid Company has appointed Louis A. Melsceimer as director of Technical Services for its Pigments division. Melsheimer joined the company in 1944 as manager of the Technical Services laboratory and in 1952 was named manager of Technical Promotion for the Pigment department.

Stauffer Chemical Company has appointed Charles A. Lindsay as general manager of its Container division. Formerly production manager for Southern California and with the company for the past 12 years, Lindsay will be responsible for all container operations, reporting directly to the president of the company.

Manning, Maxwell & Moore, Inc., has elected three new vice presidents. They are **J. Robert Kelley,** formerly a vice president and general manager of Shaw-Box Crane & Hoist division, advanced to executive vice president; **Chester H. Butterfield,** named vice president in charge of operations, and **Charles A. Moore,** who in addition to his new duties as vice president will continue to serve as treasurer. Kelley was elected vice presi-

TULSA TYPE

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FLINT STEEL CORPORATION is a 40-year old firm, but we're still youthful in our outlook and ability to get things done. We retain our youth by keeping up with all the latest developments in steel plate fabricating with modern equipment. And, we've been fabricating specialized TULSA TYPE equipment for the petroleum and petrochemical industries for 30 years. This combination of long experience and modern machines goes to work for you whenever you call on FLINT STEEL. We earnestly invite you to discuss your plate fabricating problems with us at any time.

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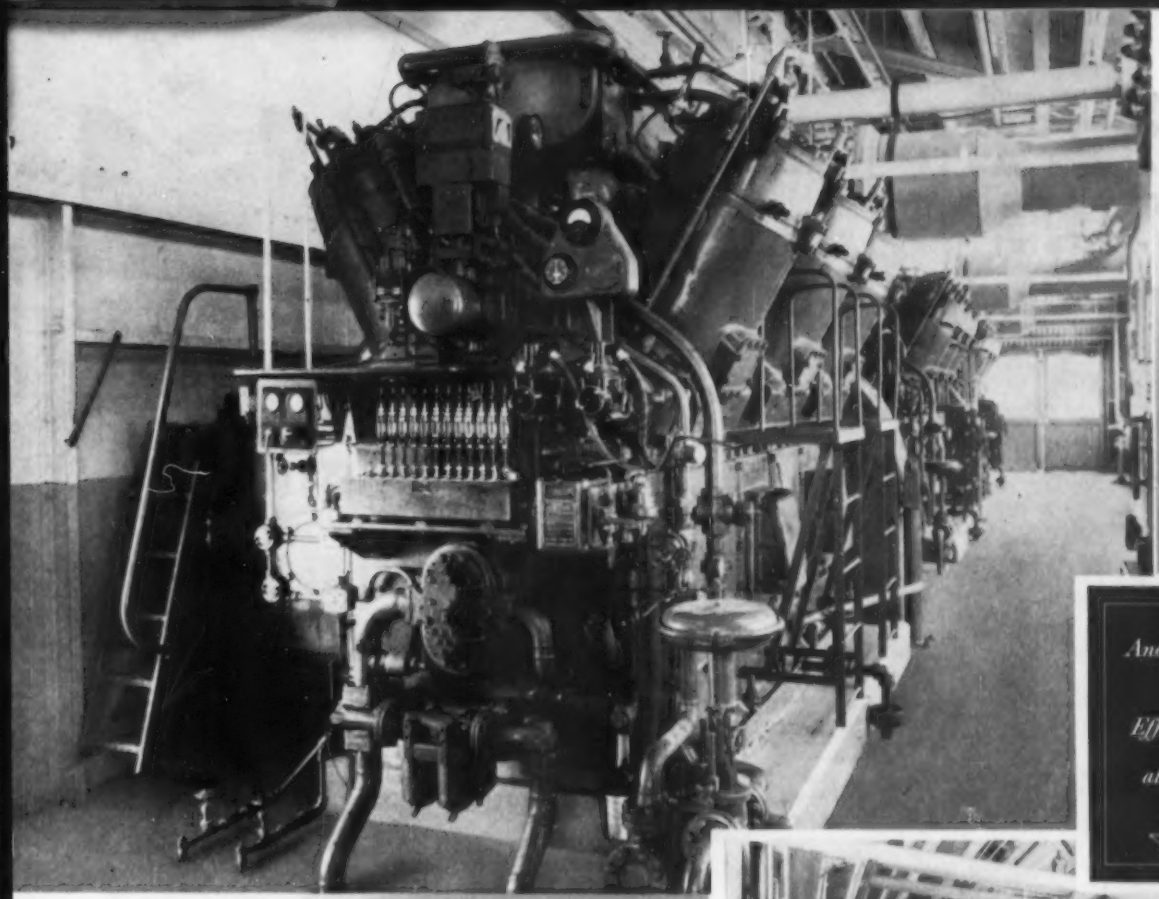
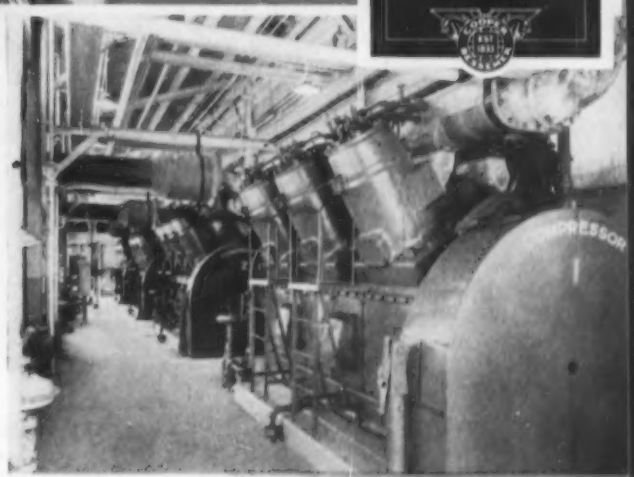


Another Example of Efficient Power at Lower Cost



Shown here are Cooper-Bessemer compressors, located at Sun Oil Company's Marcus Hook petrochemical plant. Used to handle recycle hydrogen, these four GMV's are each rated 660 hp at 300 rpm.

In hydrogen service for petrochemicals

COOPER-BESSEMER GMV's...

Where EXTREME Reliability is a MUST!

• In Sun Oil's $15,000,000 petrochemical plant at Marcus Hook, Pa., three 6-cylinder Cooper-Bessemer GMV compressors efficiently handle the recycling of hydrogen, while a fourth unit is in stand-by service. Three more similar units are being added for current plant expansion.

Employing both the Houdriforming and Udex processes, the Marcus Hook installation is designed to produce benzene, toluene and mixed xylenes, or high octane motor fuel. In the Houdriforming process, it is extremely important to maintain a continuous hydrogen supply.

Handling this vital recycle hydrogen, are 660 hp Cooper-Bessemer compressors . . . long recognized for the very best in *reliable service* and economical operation.

Like Sun Oil, you too will be performance ahead with highly efficient, trouble-free Cooper-Bessemers. So, if future plans call for compressor horsepower offering tops in dependability and flexibility, get complete facts on the latest V-angle developments.

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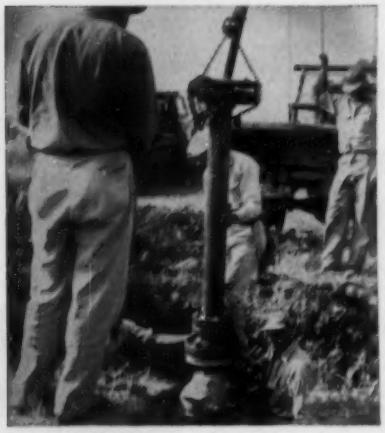

"We needed a connection on a boiler feed water line (270°-760 psi) where water treating material could be introduced into the stream. I called TOPAZ and their sales engineer specified the equipment, supervised the preparation and made the tap for us. I got good service from TOPAZ without expensive down time or unnecessary risks."

TOPAZ furnishes hot tapping service three ways . . . rental with engineering supervision . . . contract . . . or direct sales. Whether your hot tapping problem involves steam, gas, water, products or chemical lines, the safe economical answer is COMPLETE SERVICE FROM TOPAZ.

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Suppliers . . .

dent in 1938 and named a director in 1949. Butterfield, with the company since 1917, formerly was a vice president and general manager of the company's Consolidated Ashcroft Hancock division. Moore, who joined the company in 1930, was elected treasurer earlier this year.

Shell Chemical Corporation has assigned four salesmen to its synthetic-rubber sales organization. The four recently completed a training program at the company's research laboratories in Emeryville, Calif., and will be assigned to the West Coast area. They are A. D. Abshire and H. C. Findlay, both of Los Angeles; J. R. Brady, Jr., formerly of Newark, N. J., and D. P. O'Connell, who was with the company's Trade Analysis section in New York.

Union Asbestos & Rubber Company has been presented with two national safety awards and one state award for operations at its plant in Marshville, N. C. The 1954 Certificate of Safety Achievement from the U. S. Department of Labor and the North Carolina Department of Labor were given to the company, which also received a certificate of commendation from the National Safety Council.

Rhodia, Inc., has selected Naugatuck Chemical Division of Dominion Rubber Company, Ltd., as sales and technical representative in Canada. The Canadian company will sell and service both industrial reodorants and aromatic chemicals.

ALCO Products, Inc., has chosen John Thomas to serve as assistant to the company's new vice president, retired Admiral Wilson D. Leggett. Thomas will be stationed at the company's engineering headquarters in Schenectady, N. Y. He has a background of some 35 years' experience in manufacturing, engineering and sales activities.

Graver Water Conditioning Company has appointed J. D. Crell as sales engineer for its New York City district. Crell, with the company several years, will work out of the firm's main offices in New York.

H. M. Detrick Company, in a series of new appointments, elected **Louis Ellman** as president. He formerly was vice president and manager of the company's district office in Pittsburgh. Others receiving promotions were **J. C. Wilson,** district manager at Philadelphia, and **R. J. Stanley,** manager of the company's Detroit district. Both were elected vice presidents. **C. B. Edgar** was appointed to succeed Ellman as head of the Pittsburgh office.

The International Nickel Company of Canada, Ltd., has elected Ralph D. Parker as vice president. Another new appointment among the company's executives was the assignment of Walter A. McCadden as comptroller. Parker, with the INCO

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TUBING
UP TO
58 FEET LONG
FOR
CONDENSERS
and **HEAT EXCHANGERS**

Now you can get STRAIGHT lengths up to 58 feet long...at Pacific Tube

Pacific Tube Company has added new pickling facilities, new hydrostatic testing equipment...with the longest draw bench in the west to quantity-produce for you, straight lengths of Seamless Tubing up to 58 feet long. Pacific Seamless Steel Tubing is "Quality Controlled" to insure workability, accurate bending, flarability and long life. It is precision drawn to meet critical specifications and tolerances.

Pacific Tube Company is strategically located to serve you efficiently, economically & promptly.

If you have a tubing problem, ask the Pacific experts for help...you'll be glad you did.

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Manufacturers of
STEEL TUBING AND BARS

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Our movie...
"Steel Tubes for Industry"
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GOING PLACES *is always easier with Cities Service...*

Helpful directions to travelers on major turnpikes is just one small reason why the green-and-white emblem renews its welcome daily.

CITIES SERVICE
A Growth Company

Number 10 of a series

For more data on advertised products, use Readers' Service Cards, last page.

ERNST

SIGHT FLOW INDICATORS

"See What Goes On Inside"

For insertion into pipe

FOR EVERY APPLICATION

BRONZE, IRON, STEEL, STAINLESS STEEL

FIG. 29 Cylinder with Impeller

FIG. 17-28 Cylinder

FIG. 215 Flanged

FIG. E-57 Double Window

FIG. 212 Visibility Welding Neck or Screw

FIG. E-811 Flapper

FIG. E-1810 Rotating Wheel Type

All sizes up to 6" *Send for Catalog*

ERNST WATER COLUMN & GAGE CO.

LIVINGSTON, N. J.

TO REPAIR PIPE LEAKS—

QUICKLY, PERMANENTLY

ANY PRESSURE — ANY TEMPERATURE

SKINNER-SEAL EMERGENCY PIPE CLAMP for pinhole or corrosion leaks.

SKINNER-SEAL PIPE LINE CLAMP for long splits and bad corrosion leaks.

In stock — all supply stores

M. B. SKINNER COMPANY

SOUTH BEND 21, INDIANA, U. S. A.

Suppliers . . .

organization since 1928, will continue as general manager of the Canadian operations. McCadden, who also was elected comptroller for the company's U. S. affiliate, succeeds Cameron R. Whitehorne, who retired. Whitehorne also held both positions.

Blaw-Knox Company has made A. E. Hohman, its advertising manager since 1944, coordinator of special sales activities. In his new position, Hohman will evaluate advertising, sales promotion and special-marketing activities. He will be replaced as advertising manager by Paul F. Vollmer, who has served as assistant advertising manager since 1949.

Climax Molybdenum Company has added two research chemists to the staff of its Detroit, Mich., laboratories. They are **George W. Lewis, Jr.**, and **Howard S. Ring.** Dr. Lewis, who prior to joining Climax was a research chemist at Mallinckrodt Chemical Works, will be project engineer in charge of research on molybdenum corrosion inhibitors. Ring will work on molybdenum catalysts.

Stauffer Chemical Company has named Wyman L. Taylor to manage industrial chemical sales for its San Francisco district. He replaces R. N. Nason, Jr., who has resigned. With the company since 1946 and for several years in the Industrial Chemical Sales department, he was transferred from the company's district headquartered at Fresno, Calif.

Dow Chemical Company has advanced nine men in its Plastics Technical service. Six were promoted from plastics field development engineers to plastics customer service engineers. They are **William E. Brown, Robert C. Cottrell, Joseph Eveland, F. Jack Gibbs, Maurice Q. Tessin** and **Harold J. Waite.** Those advanced to plastics field development engineers are **Ted C. Broadwell, Casimer A. Burczyk** and **James L. Forse.**

Carbide and Carbon Chemicals Company has appointed Dr. T. R. Miller as director of its plant laboratories in South Charleston. Dr. Miller has been with the Union Carbide and Carbon Corporation affiliate since 1940.

The William Powell Company has elevated its president, H. James Coombe, to chairman of the board. He will continue as the company's chief executive officer. Elected to replace him as president was David M. Forker, Jr., executive vice president for the past two years. Forker joined the company in 1926. Coombe's service spans 45 years. He had been president since 1941.

The Lummus Company has elected James H. Curtis as vice president. Curtis, who was one time manager of manufacturing for General Petroleum Company, formerly was assistant to the president of Lummus. Other company changes included the selection of D. R. Breien, treasurer, to take on the additional job of secretary.

Need Plain or Jacketed CORRUGATED METAL GASKETS?

Call CHICAGO-WILCOX for PROMPT ATTENTION

Chicago-Wilcox understands the gasket requirements of refineries and is equipped to supply all types of gaskets, including plain or jacketed corrugated metal gaskets like these. Made of ingot iron, aluminum, stainless steel, copper, brass, nickel, and monel in all sizes and shapes.

Send specifications for quotations and prompt-delivery schedule.

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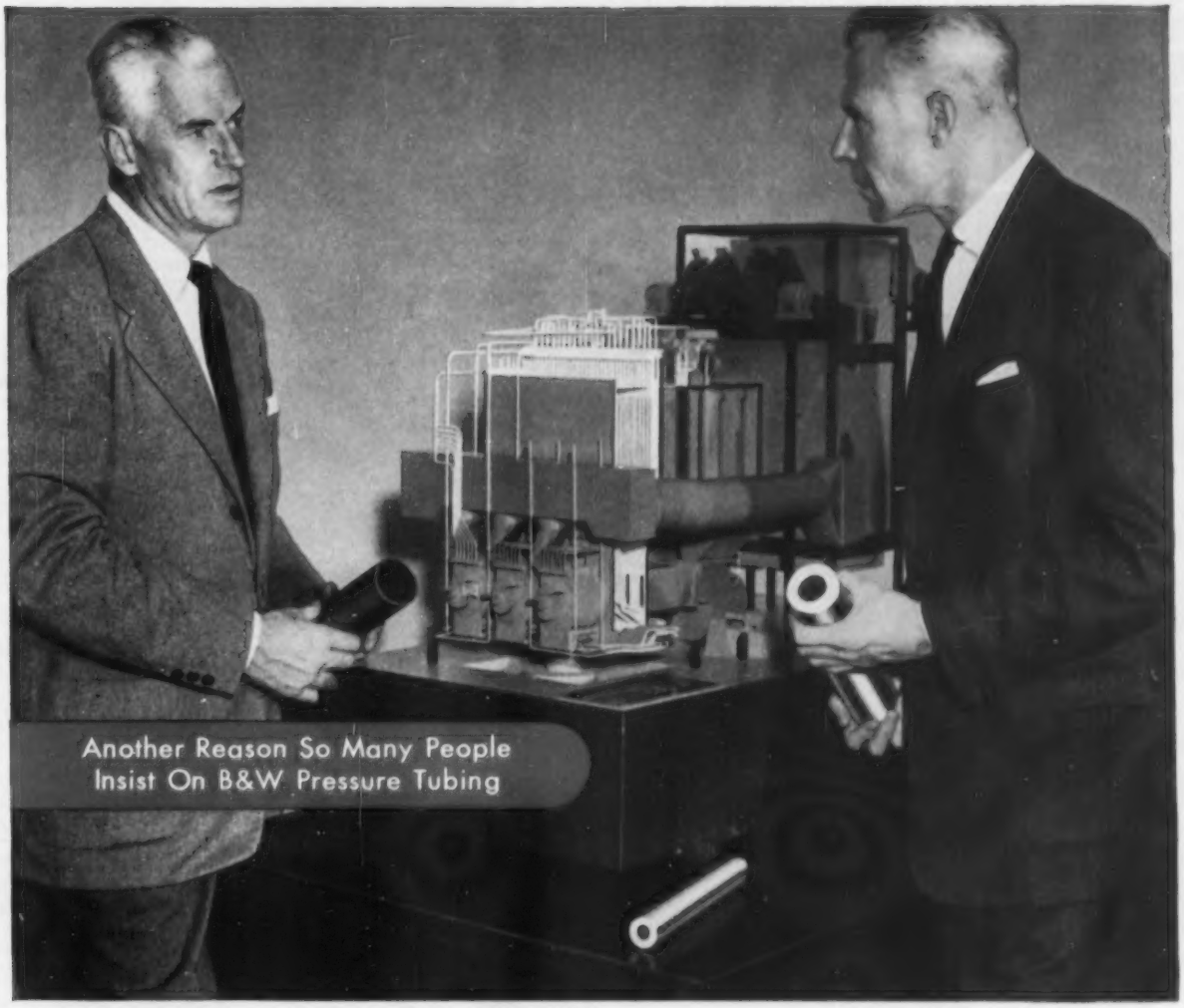

UNDER PRESSURE? TRY 4500 PSI AT 1150 F

There's a new concept in big boiler design: The Universal Pressure Steam Generator. It operates either below the critical—3206 psi—or smashes through the pressure barrier. A unit now being built has a design pressure of 5500 psi, delivers steam at 4500 psi and 1150 F. It's a "once-through" unit; put water in one end of a tube and steam comes out the other, without using a steam drum.

When B&W engineers designed this new boiler they turned to their own metallurgical and tubular products experience with alloys for pressure and temperature service to devise the tubing complex that is the heart of the unit. The chart shows the variety of analyses in sizes from 1-inch O.D. to 2½-inch O.D. and wall thicknesses from 0.10-inch to 0.55-inch.

Carbon Steel • Carbon Moly
Croloy ½ • Croloy 1
Croloy 1¼ • Croloy 2¼
Croloy 3M • Croloy 9M
Croloy 18-8

The best way to avoid operating under *personal* pressure on any job is to call for B&W Pressure Tubing. There's a grade, size, length and wall for virtually every pressure, temperature and corrosion resistance requirement. *Write for Technical Bulletin 6. PR.*

B&W
TUBULAR PRODUCTS DIVISION

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TUBULAR PRODUCTS DIVISION
Beaver Falls, Pa. and Milwaukee, Wis.: Seamless Tubing, Welded Stainless Steel Tubing
Alliance, Ohio: Welded Carbon Steel Tubing
Milwaukee, Wis: Seamless Welding Fittings

TA-5028(P)

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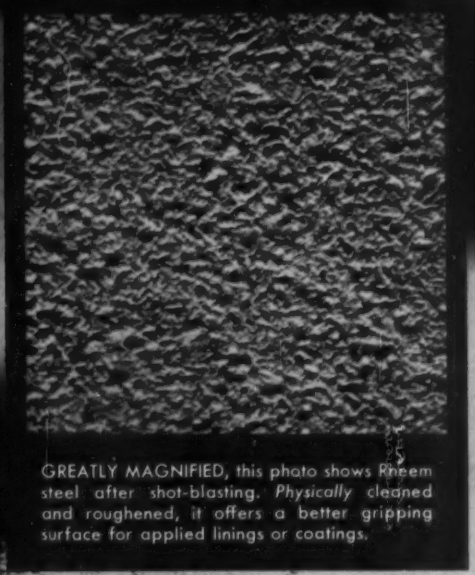
HILLS AND VALLEYS MAKE BETTER STEEL DRUMS



GREATLY MAGNIFIED, this photo shows Rheem steel after shot-blasting. *Physically* cleaned and roughened, it offers a better gripping surface for applied linings or coatings.

THIS SHOT *is the secret of Rheem's longer lasting steel drums*

Look at the insert above. It shows you the hills and valleys in a piece of shot-blasted steel . . . the steel Rheem uses to give you a better steel drum.

This shot-blasting—the first and most important step in preparing the steel for forming—*physically* cleans and roughens. Millions of carefully sized high-carbon steel pellets bombard both sides of each steel sheet . . . blasting away scale . . . roughening the surface . . . carefully preparing the metal to receive protective linings or exterior coatings.

As a result, when we apply an interior lining or outer coating to a drum, it gets a bulldog grip on scientifically roughened steel. We get a better bond of steel and coating. You get a better drum. Also, because Rheem's shot-blasting gives the steel a "passive" surface, it retards oxidation of *uncoated* sheets.

Next time you place an order for steel containers, remember this: Rheem *physically* cleans its steel by shot-blasting before fabrication. For *any* drum—plain, lined or decorated—that means longer life.

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World's Largest Manufacturer of Steel Shipping Containers

RICHMOND AND SOUTH GATE, CALIF., CHICAGO, NEW YORK, LINDEN, N. J. AND SPARROWS POINT, MD.

"It's better to ship in steel"

Suppliers . . .

Mario J. Marchione, assistant treasurer, was elected assistant secretary and assistant treasurer, and Theodore F. Brophy, company counsel, was made assistant secretary.

Rockwell Manufacturing Company has promoted Nelson E. Davenport, a sales engineer in its Meter and Valve division, to assistant gas products manager. Formerly stationed at Atlanta, Ga., Davenport will headquarter in the company's main offices in Pittsburg. Before joining the Rockwell organization, he was connected with Taylor Refining Company in Texas for three years.

Du Pont Company has appointed **Frank B. Stirling** as office supervisor for the Western region of its Petroleum Chemicals division. He replaces **T. Parvin Cook**, who retired. Formerly supervisor of the Order and Clerical section with the division in Wilmington, Del., Stirling has been with the company since 1926. He worked in the Construction and Engineering divisions of Du Pont's Chambers Works plant at Deep Point, N. J., before joining the Petroleum Chemical division in 1948.

Quaker Rubber Company, Division of H. K. Porter Company, Inc., has made Julius C. Hydrick its works manager. Formerly works manager for Quaker, he was transferred to The Delta-Star Electric Company, another Porter division, in 1951. He was works manager for Delta-Star. His duties at Quaker Rubber will include supervision of factory personnel and plant operations.

Marsh Instrument & Valve Company has opened a new manufacturing plant and sales office in Edmonton, Alba. Manager of the new Canadian plant will be **M. C. Minton. Clyde Fisher** will be in charge of the manufacturing staff.

National Can Corporation has a new assistant plant manager for its facilities in Chicago. He is Folke W. Anderson, superintendent of the plant for the past ten years.

Minneapolis-Honeywell Regulator Company has appointed John M. Wilson as chief engineer in charge of Development and design for its Brown Instrument Division. Wilson, formerly chief electrical engineer for the parent company, joined Honeywell in 1933.

Catalysator Quartz

Ultra Pure Quartz Nuclei of Crystallization for Polymeric Gasoline Plants

(CAT. POLY. REACTION)
pursuant to prescriptions of
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THE STANDARD OIL COMPANY (OHIO)

Manufacturing (Refining) Department

is looking for

CHEMICAL ENGINEERS, CHEMISTS, and MECHANICAL ENGINEERS

with one to five years experience in petroleum refining or related activities

for staff work primarily in Cleveland, Ohio.

Possible employment in Toledo, Lima, or Cincinnati, also.

Applicant should have the following educational background and industrial experience:

Chemical Engineers: B.S. or higher degree and experience in development, pilot plant operation, process design, process trouble shooting, refinery process engineering, economic studies, or related work background.

Chemists: B.S. or higher degree and experience in product and process research or development.

Mechanical Engineers: B.S. or M.S. degree and experience in process equipment construction, design, inspection, or maintenance, petroleum product testing and field evaluation, or related work background.

Age range 22-32

Salaries commensurate with experience and level in organization. Advance on merit basis.

If you can qualify and are looking for a permanent job with a growing but secure midwest company, write, giving full information on education, industrial experience, military experience, and personal data to E. G. Glass, Jr., 1737 Midland Building, Cleveland 15, Ohio.

American Cyanamid Company has developed a new catalytic-cracking catalyst of high-pore volume for the refining industry. The new pore volume is reported to bring about increased stability and cracking efficiency.

Fisher Governor Company has acquired the assets of Thermo Instruments Company, a Belmont, Calif., manufacturer of liquid-level measurement instruments. D. M. Comb, former president of the company, now is associated with Fisher Governor in Marshalltown, Iowa.

Edwards Valves, Inc., has assigned additional territory to W. E. Bowler Company, which has represented the valve company in the Philadelphia and Reading, Pa., areas since 1938. The firm was given charge of sales operations also in Baltimore, Md., and Washington, D. C.

HELP WANTED

pressure vessel designers

Educational and practical background in forces and stresses. Men who can handle other than standard methods of design. Shop experience and welding knowledge desirable. Reply fully to: **C-29, P. O. Box 3414, Phila., 22, Pa.**

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$50,000 new spare parts

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2—Pacific 6 stg., 730 GPM, 2000′ hd

6—715 sq. ft. Atmos Ht. Exchs. ADM

10—Steel heat exchangers, 1500, 360, 260 sq. ft.

30—Stainless steel Atmos. Ht. Exchs. 715, 477, 108 sq. ft.

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Several graduate engineers with minimum 5 years' experience supervising maintenance engineering functions in oil refining or producing facilities, power plants, heavy industrial installations, manufacturing plants, or related operations. To establish technical supervision, procedures, maintenance operations and schedule routine and special work for major oil producing and refining operation with all supporting facilities; i.e., housing, feeding, recreation, etc.

Salary commensurate with background and experience. Write giving full particulars regarding personal history and work experience. Please include telephone number.

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Also Chemical, Mechanical and Electrical Engineers with comparable or related experience are needed for process and project work in Arabia. Assignments and salary commensurate with experience and training.

Write giving full particulars regarding personal history and work experience. Please include telephone number.

Recruiting Supervisor, Box 23
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Process Engineer Advanced Degree. For Group Leader Process Engineering Dept. Eight to ten years experience in the chemical or petroleum fields. Must be versed in the design and application of chemical processing equipment.

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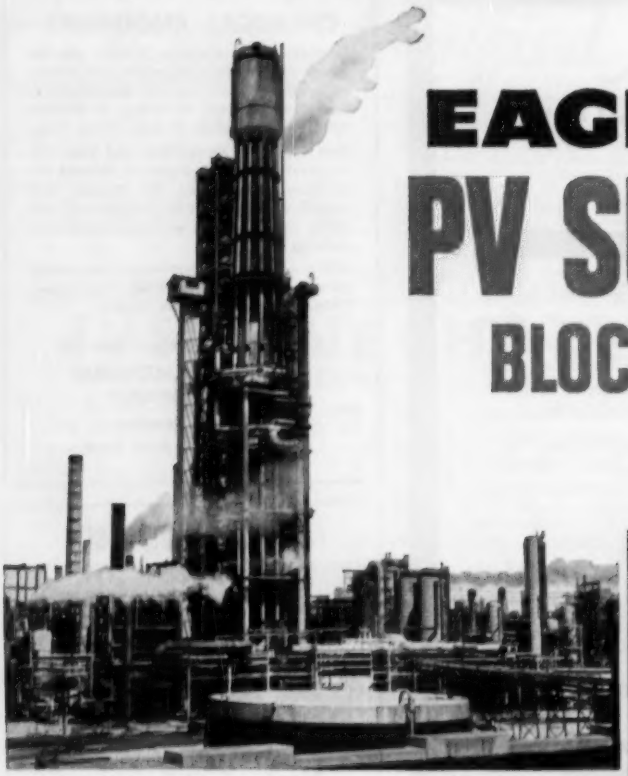

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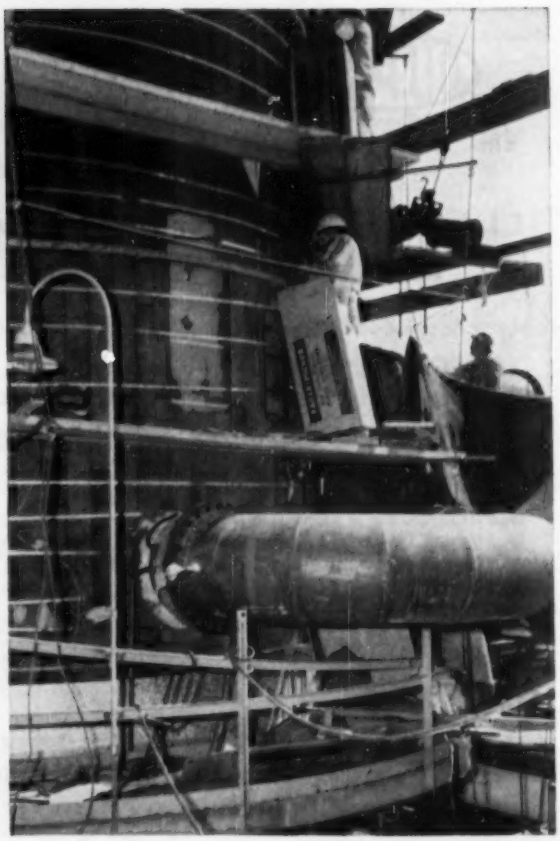

THIS IS THE GIANT, new Houdriflow at the Sun Oil Company refinery in Marcus Hook, Pennsylvania. And here's another example of the effectiveness of Eagle-Picher PV Supertemp Block for *outdoor* installation, regardless of size or shape of structure.

Because Eagle-Picher PV Supertemp Block is so water-repellent and does not disintegrate or lose its thermal efficiency when exposed to inclement weather, it saves valuable time and expense in outside construction.

You'll have this same efficient *water repellency* when you use PV Supertemp Block, for indoor or outdoor installations. You'll have an insulating block that is practically dustless, thanks to Eagle-Picher's new *precision-finish*. You'll have tremendous *structural strength* able to withstand a wide temperature range up to 1900 F. And because lightweight PV Supertemp Block is easily cut to fit irregular areas and requires only minimum reinforcing, you'll also have amazing *ease of installation.*

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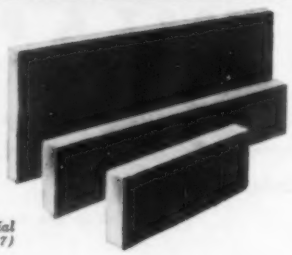
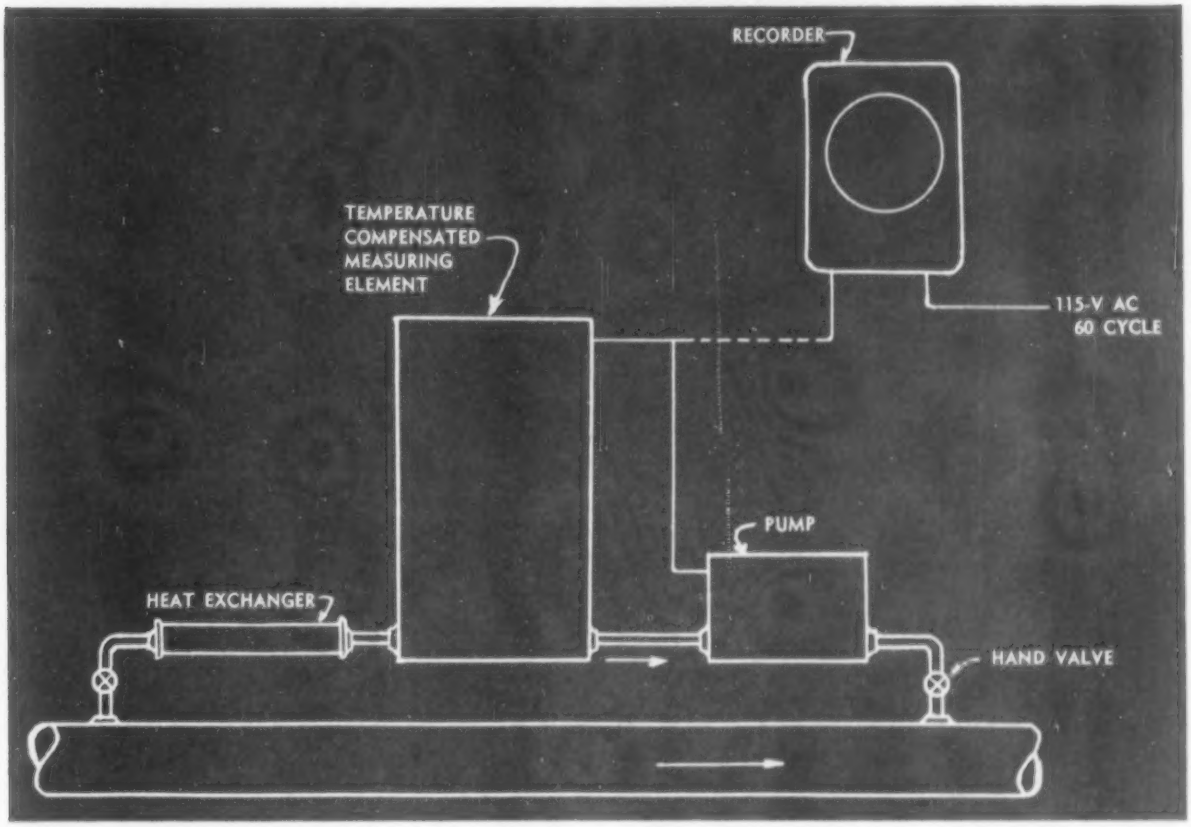


(Conforms to Commercial Standard CS117)

What's New In Equipment . . .



New instrument continuously measures and records fluid viscosity.

A Viscosimeter designed to meet the requirements of the refining of natural gasoline and petrochemical industry has been developed by the Norcross Corp. Viscosimeter is applied using a side stream. The Measuring Element Model M4A may be installed near the line where a small stream of approximately 5 gallons per hour is established for measurements at atmospheric pressure. It consists of a temperature-compensated measuring element with throttling valve to adjust the sampling, and is furnished with supply and discharge connections making it easy to install. All the electrical components of this Element meet Underwriter's requirements for Class I Group D explosion-proof equipment.

Temperature compensation is accomplished in the Measuring Element by simply using the difference in expansion of two dissimilar metals to vary an orifice in a secondary flow path. This method of compensating permits a rugged construction providing stability which is essential for high accuracy measurements. The compensating range of the instrument depends upon the viscosity-temperature relationship of the product and is normally from ± 5° F. to ± 15° F. for high accuracy. In some instances a wider temperature compensating range can be used so that exchange heaters often are not necessary to bring the sample within the compensating range of the equipment.

The Recorder can be remotely located any reasonable distance because the constants of the connecting cable do not enter into the calibration of the instrument. The Recorder R2B is furnished for recording only and the Model R2P Recorder is used for pneumatic control. The Recorder R2P, in addition to making a permanent record of the viscosity, provides two output air pressures. One is a function of the measured viscosity and the other is the control set point pressure. Indicating air gauges are furnished for each air pressure with an adjusting knob for control point air pressure so that this Recorder can be conveniently used with any pneumatic controller using 3-15# air pressure. Model M4AR2P for recording with pneumatic control.

A pump is available to return the sample to the pipe line. An explosion-proof motor used to drive the pump can be readily connected electrically from the supply going to the Measuring Element, making a simple installation.

An exchange heater is available as an accessory to bring the temperature of the sampling oil within the compensating range of the instrument. The exchange heater can be furnished with control for maintaining the proper temperature.

The accuracy of this model depends upon the application but normally better than ± 1% can be expected. Uncompensated Norcross Viscosimeters have been furnished with less than ± ¼% and an overall accuracy of ± ½% can be obtained in many temperature compensated installations.

The basic principle of measuring viscosity with Norcross Viscosimeters is simple, permitting a rugged construction capable

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of providing dependability and long life with a minimum of maintenance. Even more important, any maintenance department can easily service this equipment.

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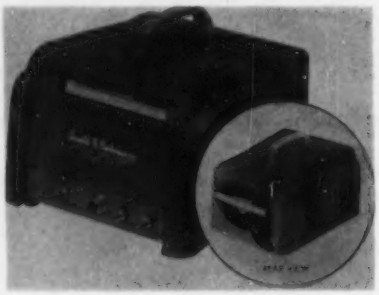

A new oxygen analyzer, operating on the paramagnetic principle, has been announced by Arnold O. Beckman, Inc.

The new instrument, designated Model C2P Oxygen Analyzer, is particularly designed for applications requiring a quick, simple, accurate means of measuring oxygen with an instrument that is portable for convenient use in the field, plant, or laboratory.

The Model C2P can be used for measuring continuously-flowing samples, or for fixed volume samples as small as 3 cc. Practically any desired range of 5 percent or more between 0 and 75 percent oxygen, and ranges of 15 percent or more between 75 percent and 100 percent oxygen are available. Accuracy in any range are within plus or minus 1 percent of full scale. 95 percent response to final reading within 40 seconds on standard models or within seven seconds on special models is available. The scale is direct reading and may be calibrated in either percent oxygen or millimeters of mercury oxygen partial pressure.

Full information is available now. Just...

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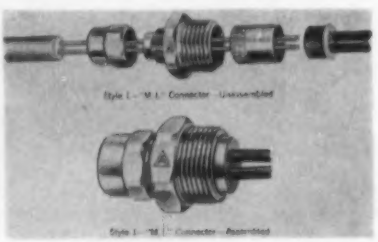

A new series of connectors which greatly simplify the installation of the newly-introduced Safety Mineral Insulated Cable are available now from Appleton Electric Company.

Called the "M. I." series, the new Appletion requires no paste or compound to achieve a proper seal on the cable end. Instead, a Neoprene "button" that is locked tight against the cable end by the simple expedient of tightening a nut. These connectors preserve the features of

IN PETROLEUM (*Oil and Gasoline Additives*)

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More and more industries in the petroleum, surface coating and chemical fields are relying on Enjay to help move their products fast. For Enjay supplies them with a complete line of uniform, high quality petroleum chemicals that assure dependable product performance and proved results. Enjay is also ready to assist you in developing new or improved products through chemistry. For petroleum chemicals backed by 35 years research, experience and know-how, *next* time, call on Enjay.

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PARATAC	Secondary Butyl Acetate	Decyl Alcohol
PETROMOL	Isopropyl Acetate	Denatured Ethyl Alcohol
Methyl Ethyl Ketone	Acetone	Tridecyl Alcohol
Dewaxing Aid	Methyl Ethyl Ketone	Dicyclopentadiene
Ethyl Ether	Dicyclopentadiene	Isoprene
Isopropyl Ether	Ethyl Ether	Butadiene
Reference Fuels	Isopropyl Ether	Ethyl Ether
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RUBBER	Iso-Octyl Alcohol	Tetrapropylene
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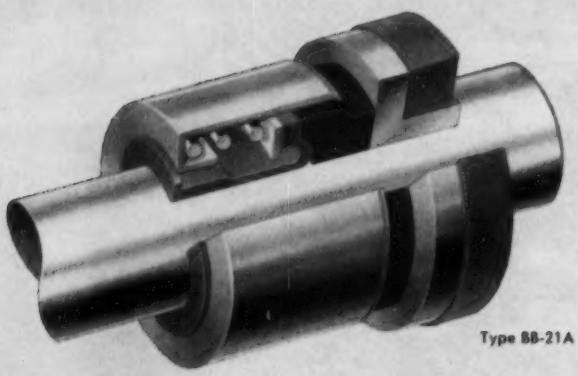

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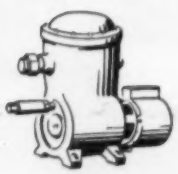
This MECHANIPAK Seal occupies a very small space—specifically designed for rotary pump shafts. It comes completely assembled, ready to install. Standard construction includes brass shell, brass washer and Buna-N bellows. Other materials available. Furnished for shafts from 3/8" to 3" diameters.



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Customers tell us the MECHANIPAK Seal *pays for itself.* (1) Reduces maintenance costs (2) Absolutely no shaft wear (3) Cuts down time.

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Installation time and labor costs are reduced because there are fewer components to assemble. Appleton "M. I." series connectors are now available for use with safety mineral insulated cable ranging from size 14 to size 10, 2 conductor to 4 conductor. Complete details on these connectors as well as a description of the simple installation technique are available now. Just . . .

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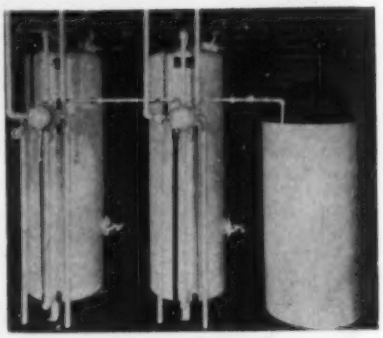

New standard model Zeolite water softeners have been announced by Industrial Filter and Pump Manufacturing Company. Made in 13 standard sizes with flow rates from 6.5 to 40 gpm, these softeners will satisfy demands for small volumes of soft water in the refining, natural gasoline and petrochemical industries.

These INDUSTRIAL zeolite water softeners are of simple design for convenient operation through a single multiport valve. They can be supplied with either automatic or semi-automatic controls.

For complete information, simply . . .

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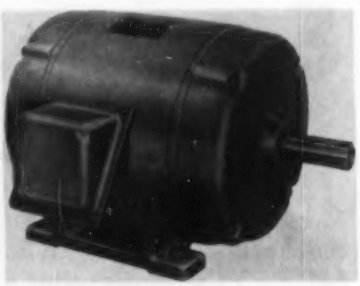

Ball-bearing polyphase motors in rerated NEMA frame sizes 182 through 326 have been announced by Wagner Electric Corporation.

The new line, designated type DP, come with corrosion-resistant cast iron frames and is suitable for indoor or outdoor use. Frames are smoothly contoured so that moisture cannot collect on their surfaces

There's a faster, safer, cheaper, more accurate way to measure tanks with... a new

Gilbarco

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A crew of hand gaugers can climb slippery steel stairways in icy cold to lower tapes through opened manholes. Or one man can sit in a gauge house before a Gilbarco Remote Receiver and gauge tanks at the rate of fifty an hour—with a degree of accuracy never approached by *any* other method. Here is *automation* in tank gauging. For illustrated booklets and full information about this great new advance in liquid level measurement, write . . .

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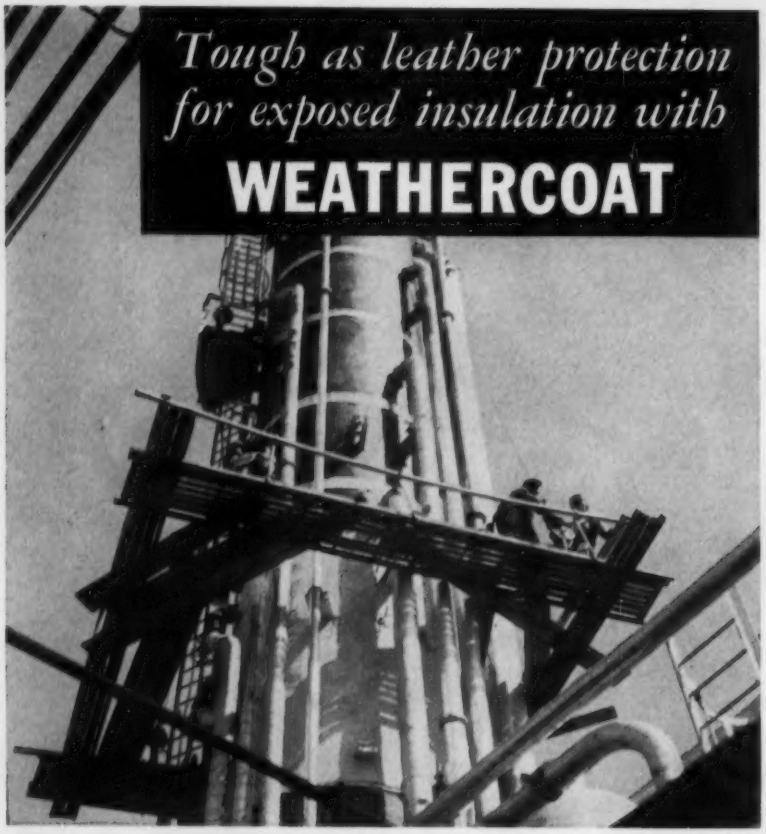

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Thermal insulation on outdoor operating facilities needs a "raincoat." This material depends upon small air spaces formed by the flake fibers, or spheres of solids in the insulation itself to retard the flow of heat (or cold). Should moisture fill all or part of these air spaces the efficiency of the insulation would be seriously affected.

Weathercoat gives lasting protection. Weathercoat has an extremely high resistance to moisture in all its forms. (It has a Perm rating of 0.0175 for 0.10" thick dry film.) It is a factory compound of asphalt emulsion and mineral fillers and fibers that sets to a smooth, tough and pliable finish. Because no clays or other hydrophilic fillers are used in Weathercoat, it stays "alive." This assures long-lasting protection for insulated surfaces.

Nation-wide acceptance. Many of the largest refineries, chemical plants, and power stations in the nation are regular users of Weathercoat, both for maintenance and for new construction. During the last year alone, over 5 million sq. ft. of insulation have been coated with Weathercoat. The Laykold Engineer in our office nearest you will supply full details.

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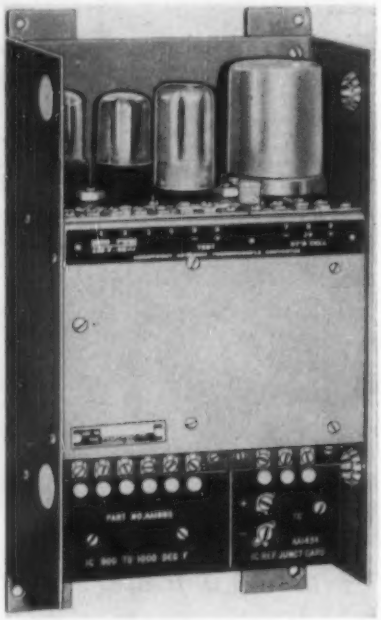
San Juan 23, P.R.

New Equipment . . .

and construction is so completely dripproof that the motors can be used for many applications formerly requiring splash-proof motors.

Type DP motors will be available from Wagner in 1 to 30 horsepower ratings, 3 phase, 60 cycles, 1750 rpm. A new bulletin, MU-202 describes their construction features in detail. This bulletin and other information is available now.

Circle E5 on Postcard



A new amplifier-converter which enables the "Autronic System" of all-electronic control to be used with thermocouples or other low-voltage d-c inputs has been announced by the Swartwout Company. Designated as the type T2C Autronic Thermocouple Converter, the unit is now in volume production and available for short-term delivery.

The T2C Converter is a high-impedance, null-balance unit which does not draw current from the thermocouple. Although designed for a minimum span of 2 millivolts, the T2C Converter will operate at spans as low as 0.400 millivolts.

Range is quickly and easily altered, by means of interchangeable range cards. Span accuracy of the instrument is 0.5 percent, reproducibility 0.25 percent of span, and ultimate sensitivity 0.1 percent of span.

Full details on the Swartwout Autronic T2C Thermocouple Converter are available now. Just . . .

Circle E6 on Postcard

A Manual-Reset Valve for emergency safety services requiring quick, positive action has been introduced by Black, Sivalls & Bryson, Inc. Named Type 73-20, the valve combines simplicity of design with positive action. It is recommended for use as a safety shutoff in either liquid or gas

This is the first in a series of summaries of the economics of electrical desalting. Careful study of operating data and maintenance records demonstrates conclusively that the payoff for electrical desalting averages more than 100% per year.

TECHNICAL REPORT

SUBJECT:

ECONOMICS OF ELECTRICAL DESALTING

FROM:

RESEARCH FILES OF HOWE-BAKER CORP.

ECONOMICS OF DESALTING

1. CREDITS FROM INCREASED CRUDE CAPACITY

The capacity of a given crude distillation unit has been increased as much as 50% by using electrical desalting for the removal of water. This is relatively independent of the salt content of the crude and is indicative of why refiners with even very low salt content crudes (below 20 ptb) can justify desalting.

All crude stocks contain some water, usually about 1%, depending on the tank settling time allowed. Further, it is common practice to inject an additional 1 to 3% water ahead of the preheat exchangers to reduce fouling. Water requires **exactly ten times as much heat** to vaporize it as oil does. Thus, for every one barrel of water removed from the feed, 10 barrels of oil can be added. For example, at a crude distillation unit charging 10,000 B/D and with a feed containing 2% water (200 B/D), here is what happens with the addition of electrical desalting. The water is reduced to 30 B/D, a net removal of 170 B/D. Since this can be replaced with ten times as much oil, the **net increase in capacity is 1700 B/D.** This credit alone is frequently sufficient to justify electrical desalting.

Vapor capacity often limits in both prefractionator and atmospheric tower. Where this occurs, the removal of water has this same 10:1 capacity effect.

A second gain in capacity results, of course, from the elimination of downtimes for exchanger cleaning, or from operating at reduced throughputs while exchangers and preheaters are cleaned. Salt, ash, and other solids present in all crudes consistently foul exchangers, transfer lines, furnace tubes and headers, and the lower trays in towers. This type of fouling, with the associated expensive downtimes or slow downs, are eliminated.

The credits for increased crude capacity are conservatively estimated at 4.6¢/Bbl.

SUMMARY OF CREDITS

	¢/Bbl
1. Increase Crude Capacity	4.6
2. Reduce Maintenance	1.1
3. Improve Cracking Yields	1.6
4. Reduce Corrosion	0.6
5. Increase Tank Capacity	0.2
Total Credits	8.1

Write today for your copy of the complete report to:

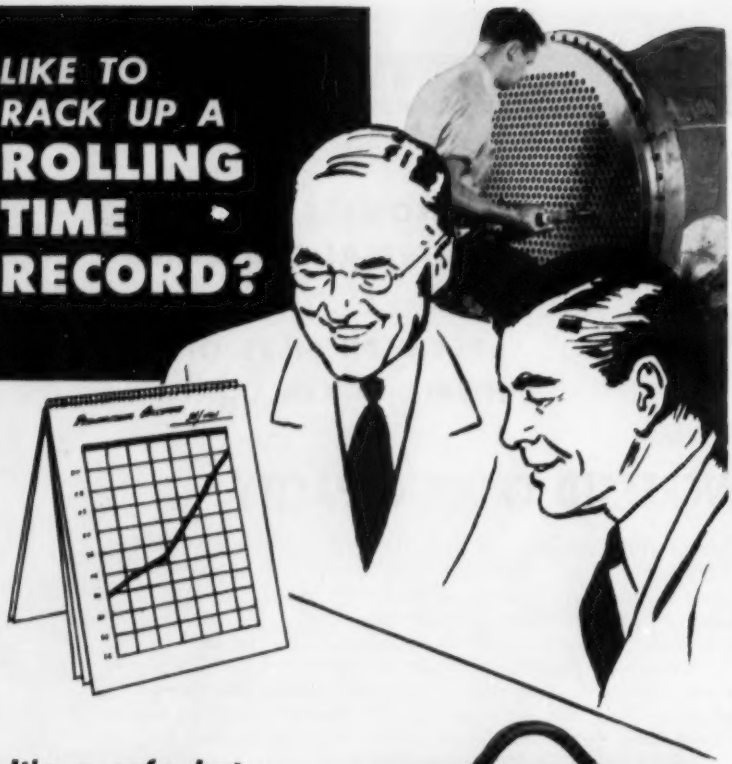
SPECIALISTS IN PETROLEUM EMULSIONS

HOWE-BAKER CORPORATION
ESPERSON BUILDING HOUSTON, TEXAS

OVER 1,000,000 BARRELS OF CRUDE PROCESSED DAILY BY THESE HOWE-BAKER CUSTOMERS.

Esso · ATLANTIC · SINCLAIR OILS · PURE · HUMBLE · SUNOCO

LIKE TO RACK UP A ROLLING TIME RECORD?



It's a safe bet you WILL . . . with an AIRETOOL Tube Expansion Control System

Nothing beats betting on a *sure* thing! And that you do when you rely on the Airetool tube expansion control system. Automatic, the Airetool system with its preset control quickly rolls joints to a uniform tightness. Gives maximum bonding between tube and sheet. Over-rolling is, therefore, eliminated . . . and rolling time is notably shortened, from hours to minutes.

Motors are available in four sizes to supply proper power for your purpose. Entire system is portable.

Call for an ON-YOUR-JOB DEMONSTRATION Today!

BRANCH OFFICES:
New York, Chicago, Philadelphia, Tulsa, Houston, Baton Rouge.

REPRESENTATIVES
in principal cities of U.S.A., Canada, Mexico, England, South America, Puerto Rico, Japan, Italy, Hawaii.
European Plant: Airetool Nederland N.V., Vlaardingen, The Netherlands.

"There's an Airetool Tube Cleaner and Tube Expander for Every Type of Tubular Construction."

New Equipment . . .

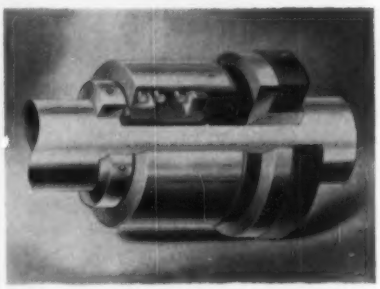
fuel lines, as a safe open valve for steam or foam or foam fire snuffing systems, or to shut down pipelines that indicate a line break by loss of pressure.

The Type 73-20 utilizes bodies, trim, and topworks of BS&B Diaphragm Control Valves with delatching trip mechanism to provide any usually specified safety requirement, with such response remaining effective until manually reset.

Technical information on this new valve is available now.

This item supplements Black, Sivalls & Bryson, Inc., data on pages 197-204 of The Refinery Catalog, 22nd Edition.

Circle E7 on Postcard



A Mechanical Seal, specifically designed for use on rotary shafts at pressure up to 150 p.s.i., has been announced by the Garlock Packing Co.

Called Garlock BB-21A Mechanipak Seal, it is furnished completely assembled and ready to install. Standard construction includes brass shell, brass washer, and Buna-N bellows. Seals are available for shafts from 3/8" to 3" diameters.

Neoprene or Buna-N bellows are furnished for operating temperatures up to 212°F. and pressures up to 150 p.s.i. Silicone bellows are provided for temperatures up to 400°F. where pressures do not exceed 50 p.s.i.

These seals are designed to provide the following benefits:

- Eliminate wear on shafts and shaft sleeves.
- Eliminate fluid leakage.
- Reduce downtime.
- Cut maintenance costs.

Complete information is available now.

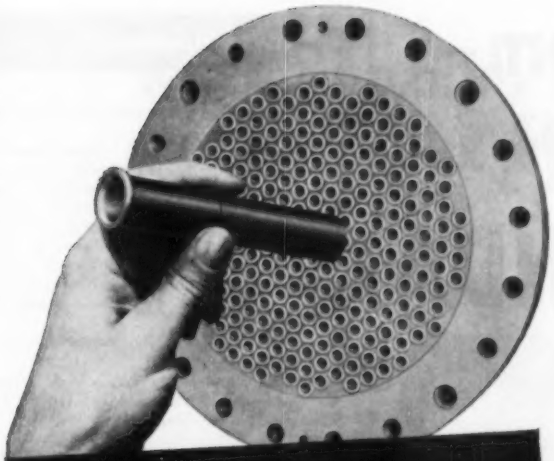
This item supplements Garlock Packing Company data on page 439 of The Refinery Catalog, 22nd Edition.

Circle E8 on Postcard

Kaowool, a pure white homogeneous fiber made by melting and blowing kaolin, is now available in blanket form, according to an announcement recently made by Babcock & Wilcox Corporation.

Currently Kaowool is being used as an insulating blanket in the afterburners and tailpipes of jet engines, where it successfully withstands temperatures up to 2,000 F. indefinitely.

Babcock & Wilcox is now producing Kaowool at its Research Center in the form of a tough resilient blanket. No organic binder is used to hold this blanket together. Hence, the blanket retains its full strength and coherence at much higher



Profit Two Ways With...

WILSON Condenser Tube Inserts

1 Put Equipment Back on Line Faster

You save man-hours and money with new Wilson Condenser Tube Inserts because they eliminate the need to plug off leaking condenser or heat exchanger tubes. Wilson Inserts go in fast...need no cementing... take less time than it does to plug a "bad tube". What's more, these highly efficient inserts put the tube back into operation as in the original design.

2 Multiply Service Life of the Tube

In many cases, condenser tubes usually fail within the first few inches of the inlet. Wilson Condenser Tube Inserts actually restore these leaking tubes to service by sealing the deteriorated portion of the tube. Wilson Inserts also retard or eliminate the effect of inlet end erosion.

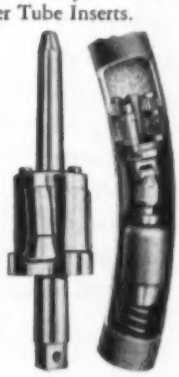
Send for Bulletin 500 which gives the full story on time-saving, money-saving Wilson Condenser Tube Inserts.

Wilson Tube Cleaners

Depend on these powerful, fast-acting cleaners to do a thorough job every time. There's a Wilson cleaner for all types of tube or pipe. All sizes in stock for immediate delivery.

Wilson Tube Expanders

For re-rolling old tubes or installing new ones. Precision-made to insure firm seating. Self-feeding and parallel expansion for a particular trade.



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TW641

WILSON

TUBE CLEANERS • TUBE EXPANDERS

See POSEY

For Large O. D. Low Alloy Steel PIPE

For Specialized Uses In Oil Refineries And Power Stations

You can depend on Posey to meet your requirements in large O. D. alloy steel pipe . . . and you can depend on Posey to turn out your job economically and on time.

- *Posey Alloy Steel Pipe is fabricated in accordance with ASTM specifications, Class A 155-52 aT.*
- *Posey specializes in large O. D. Pipe and Pilings of low and high alloy steel, alloy clad steel, carbon steel, and wrought iron.*

ELEVATED TANKS • HORIZONTAL TANKS • STACKS
PRESSURE VESSELS • DIGESTERS
CARBON STEEL AND ALLOY STEEL PLATE FABRICATION

POSEY IRON WORKS, INC.

Steel Plate Division
LANCASTER, PA

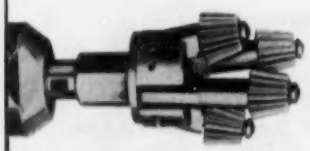
New York Office: Graybar Bldg. — Established Since 1910

When coke is stubborn—

...TRY LAGONDA

The famous Lagonda 1100 Series refinery motor, with Type UO cutter head. A widely used combination.

For tubes of wide tolerance – the Long-Surface Swing Frame head.



For tough, uneven coke – the Type H-2 head.

FOR CONDENSERS AND HEAT EXCHANGERS

Direct-drive air or steam driven cleaner with long shaft, the motor supported outside the tube by overhead pipe. Motor has trigger control. Also available with electric motor.

Occasionally you run into a brand of coke that laughs at everything you've got in cleaning equipment. Something different is indicated, and often that something is a change to Lagonda 1100 Series cleaners armed with a tough-slugging Lagonda head selected on the basis of Lagonda "know-how"—usually a pretty successful combination, and certainly worth trying when the time-out bill is climbing.

Lagonda cleaners have been on the job ever since the first still started up, and Lagonda engineers are veterans of many a tough coke battle. This experience is at your service. Phone your local Lagonda man, or write Elliott Company, Springfield, Ohio. Try Lagonda—it may well be the right answer.

ELLIOTT Company

Y4-3

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

New Equipment . . .

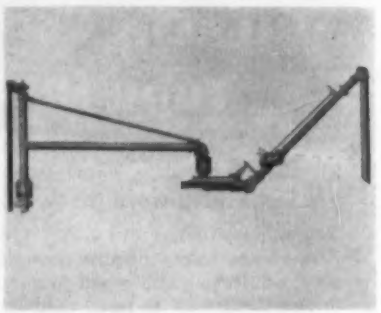
temperatures than refractory blankets using organic binders.

The new process for manufacturing Kaowool first involves the electrical melting of kaolin clay. The molten material then streams through a tapping nozzle and is blown into fibers. The processed Kaowool is then collected on a pad-forming conveyor. The material does not melt below 3,200 F. and as a fiber can withstand temperatures up to 2,000 F. without change or loss of resiliency.

For more complete information on this new product, simply . . .

This item supplements Babcock & Wilcox Corporation data on pages 165-168 of The Refinery Catalog, 22nd Edition.

Circle E9 on Postcard



A preassembled long-range loader has been recently introduced by Oil Equipment Manufacturing Company. Available in 3-inch and 4-inch sizes, this loader, No. 462, by virture of its extreme long range, facilitates the quick and simplified loading of tank cars and transports without respotting.

This assembly is equipped with two of Oilco's Timken Tapered Roller Bearing swing joints, which insure positive alignment and greater friction-free load capacity. These swing joints are packed with "O" ring seals operating against smooth chrome surfaces to prevent leakage and wear. The unique design of these joints simplifies the replacement of the rings—the operation being performed in fifteen minutes without dismantling any connection.

This improved loader is custom built to meet individual requirements. Oilco has issued a descriptive folder, which is unique in its style and completeness. Servicing notes are a feature of the folder.

This item supplements Oil Equipment Manufacturing Company data on page 652 of The Refinery Catalog, 22nd Edition.

Circle E10 on Postcard

An explosion-proof electrostatic drain and grounding indicator to eliminate dangers of explosion caused by electrostatic sparks has just been put on the market by Nelson Electric Manufacturing Company.

The unit is used to actuate a visual alarm or may be connected to make a pump start-up impossible when a dangerous condition exists.

Easily installed and low in cost, this device is for use on gasoline truck loading

WHEN BUILDING FACILITIES TO MANUFACTURE PETROCHEMICALS . . .

USE ORBIT VALVES®

Orbit Forged Steel ASA Class valves are compact in design, streamlined, and built for continuous heavy duty service. Available in both Carbon and Stainless trim: Full Round Opening in sizes 1″ to 4″ Flanged and Screw End. Venturi Opening; Flanged only, sizes 2″ to 6″.

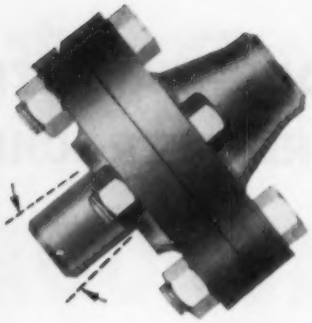
See 22nd Edition of Refinery Catalog or write for Catalog 55-B.

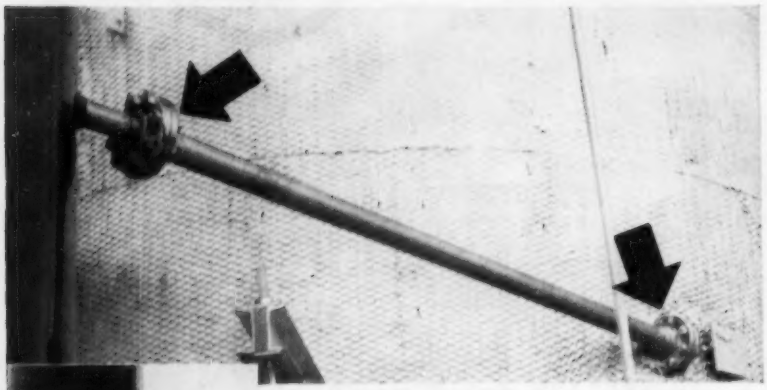
ORBIT VALVE COMPANY

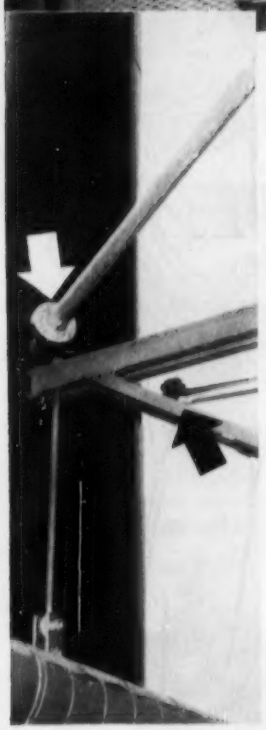
P. O. BOX 699 **(For over 40 years)** **TULSA, OKLAHOMA**

For more data on advertised products, use Readers' Service Cards, last page.

HERE'S HOW
Refinery Engineers and Builders Use
BARCO FLEXIBLE STRUT JOINTS







—for Structural Applications

Barco Flexible Strut Joints are an important aid in *modern* refinery construction. A typical use is at the ends of struts for supporting or bracing large catalyst carrier lines or vent stacks on fluid catalytic crackers. In such cases, where horizontal lines require supports, two braces (with Barco Strut Joints in each) make costly "A" frames unnecessary. Other uses include guying tall vessels and columns and directing thermal movements of high temperature piping.

SIMPLE, VERSATILE!—The Barco Strut Joint is a dependable, compact, versatile fitting requiring practically no maintenance. It is a simple ball and socket that provides a point of flexibility. The close fit between ball and casing, allows for reversible loads, not possible with pin and clevis type braces. Barco Strut Joints support without restricting freedom of movement.

COMPLETE LINE—Available in following sizes and capacities: 1½"—8,000 lbs., 2"—12,000 lbs., 3"—20,000 lbs., 4"—50,000 lbs., 6"—130,000 lbs. Welding ends for field or shop use. Unique "Bar-Moly" treatment of wearing parts provides permanent dry lubrication for long service.

ENGINEERING SERVICE—Barco will be glad to work with your engineers in the selection of joints to meet your requirements. *Specifications and information on request.*

SEND for your copy of interesting new illustrated bulletin No. 28 showing OIL REFINERY AND PETROLEUM INDUSTRY applications for Barco Ball, Swing, and Strut Joints.

BARCO *Manufacturing Co.*

542H Hough Street • **Barrington, Illinois**

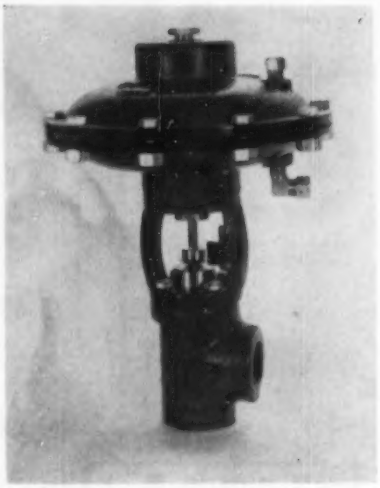
New Equipment . . .

racks, tank car loading and unloading operations, tanker loading and unloading operations and any place where explosive or flammable objects are loaded or unloaded.

Complete details on this new drain and grounding indicator are available.

This item suplements Nelson Electric Manufacturing Company data on page 621 of The Refinery Catalog, 22nd Edition.

Circle E11 on Postcard



The high pressure motor valve featuring rugged construction, compact design, and low cost has been announced as available by Kimray, Inc.

This new valve is designed for 4,000 psi working pressure and can be used for handling both gases and liquids in the refining, natural gasoline, and petrochemical industries. Some of the features of the new valve are:

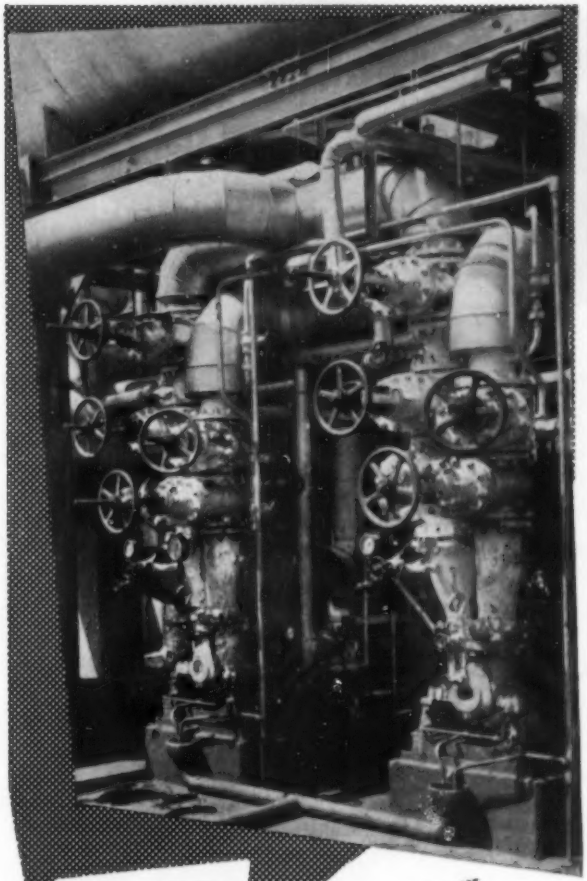
- Screwed ends: Angle or thru body.
- Reversible: pressure opening or pressure closing
- Carbide plug and hardened chrome alloy seat.

For complete details on the new and economical high pressure valve, simply . . .

Circle E12 on Postcard

Joy Manufacturing Company has announced the introduction of a new line of hydraulic hose and couplings, tradenamed "Surgepruf," for medium-high and high pressure service. Manufactured to J.I.C. standards, the couplings feature a double wedged grip which makes possible assembly on rubber covered hose without skiving. Through the use of a special slotted bushing, the manufacturer has made possible retightening of the coupling on the hose without disassembly, should it come loose through flexing or vibration. For further ease in maintenance, the manufacturer has designed the coupling so that no special tools or mandrels are required for assembling Surgepruf couplings on the hose.

Circle E13 on Postcard



B&R

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in many countries successfully equipped their modern plants with

- Gate Valves
- Globe Valves
- Swing Check Valves
- Safety Valves

Valves are manufactured according to API specifications. Flange dimensions conform to ASA. Materials correspond to ASTM.

One trial with our valves will make you our customer for ever.

Please ask for catalog We 110e with detailed particulars on our lines of oilfield and refinery equipment.

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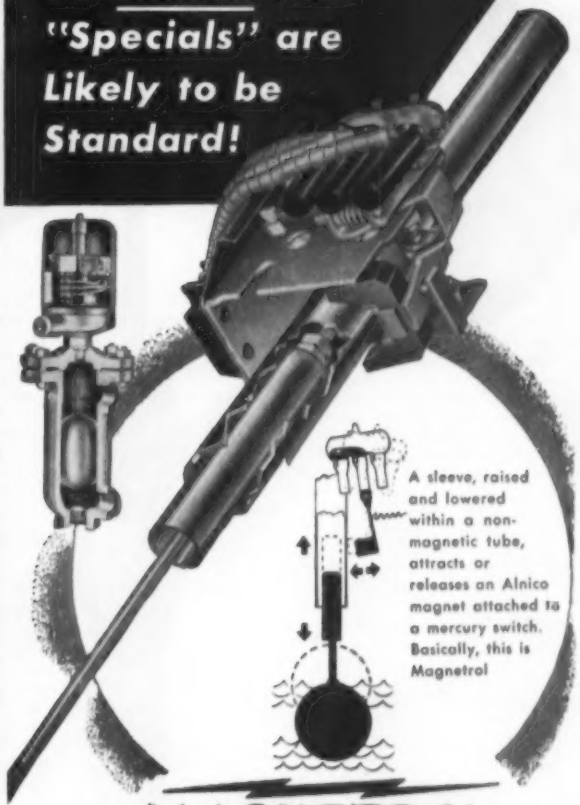
We 537 A

So SIMPLE that "Specials" are Likely to be Standard!


A sleeve, raised and lowered within a non-magnetic tube, attracts or releases an Alnico magnet attached to a mercury switch. Basically, this is Magnetrol

MAGNETROL

The World's Most Dependable

LIQUID LEVEL CONTROL

Because of the utter simplicity of Magnetrol's magnetic operating principle, standard models can be easily adapted to meet any special requirements for pressure, temperature or corrosive liquids . . . and usually at little extra cost. This Magnetrol versatility has solved all kinds of tough level control problems . . . and given our engineers wide application experience that can be invaluable to you.

Magnetrol is so simple that failure is all but impossible! Using only permanent, unfailing magnetic force for its operation, there's nothing to wear out . . . no diaphragms or bellows to stiffen and rupture . . . no electrodes to short or corrode . . . no packing to bind or leak. Magnetrol is practically maintenance-free! Magnetrol units are available for controlling level changes from .0025-in. to 150-ft. . . . with multi-stage switching when desired. Send coupon for full details.

MAGNETROL, Inc.

Send Coupon For Full Details

MAGNETROL, Inc., 2112 S. Marshall Blvd., Chicago 23, Illinois

Please send me catalog data and full information on Magnetrol Liquid Level Controls.

Name_____

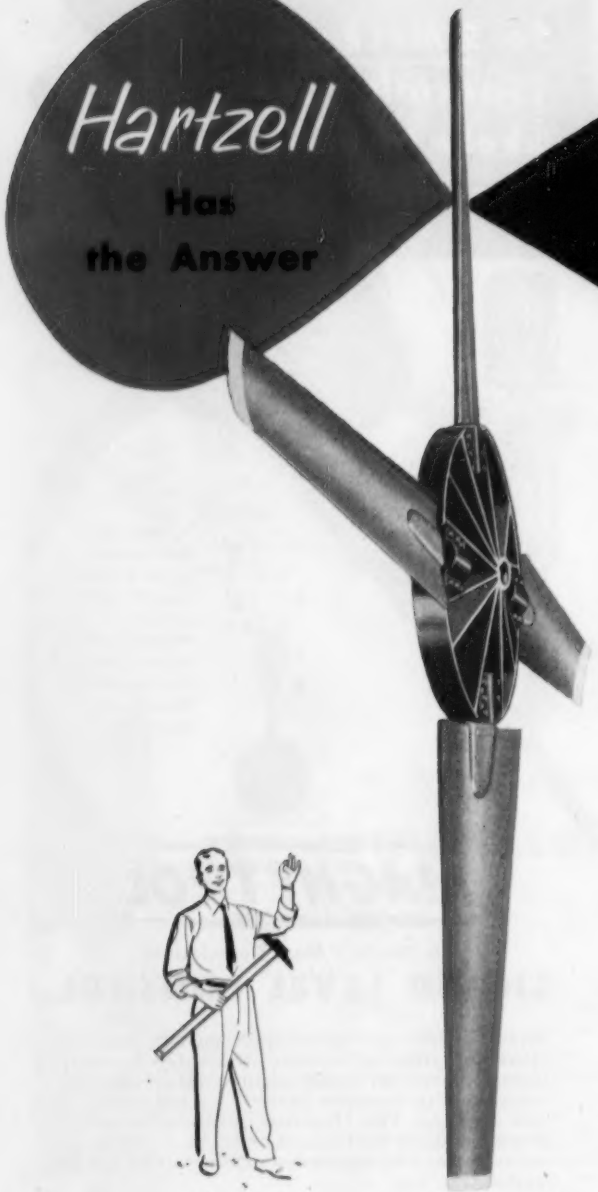
Company_____

Address_____

City_____ Zone_____ State_____

Hartzell Has the Answer

. . . To Your Replacement Problems With Cooling Tower and Heat Exchanger Fans



If you're constantly replacing the fans on your cooling towers and heat exchangers, try a Hartzell the next time. These rugged, efficient propellers will solve your fan problems.

Hartzell's exclusive Hartzite plastic has proved itself in hundreds of punishing petroleum industry installations as the blade material most resistant to corrosion, abrasion and mechanical damage. Hartzite blades are formed of phenolic-impregnated fabric. If the surface of the blade is scratched or nicked, the inside material has the same resistance to corrosion and abrasion as the outer surface.

That's one reason why, where one Hartzite fan has been installed on a battery of cooling tower cells, "Hartzell" is almost invariably specified as other fans need replacement.

Don't delay. Put an end to your problems with cooling tower and heat exchange fans by switching to Hartzell. For complete details, call your nearby Hartzell field engineer or write for your free copy of Bulletin A-111A.

HARTZELL *propeller fan co.*

Div. of Castle Hills Corp.

Please send me a copy of Bulletin A-111A, "Hartzell Cooling Tower and Heat Exchanger Fans."

Name _____

Company _____

Street & Number _____

City & State _____

If student, check here for special information ☐

Dept. K

PIQUA, OHIO

PROPELLER-TYPE FANS • BLOWERS
ROOF VENTILATORS • UNIT HEATERS

ENGINEERING OFFICES IN PRINCIPAL CITIES

What's New in Manufacturers' Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.

"Roto-Types and Boiler Plate", a 32-page brochure just published by Steel & Alloy Tank Company, Inc., describes the art of fabricating metals of odd shape and complex design for the refining natural gasoline and petrochemical industries. This attractively designed book contains many illustrations of components built of stainless and alloy steels for use in various refining operations requiring high and low operating temperatures and pressures. The reactions of stainless and alloy steels under the stresses of fabrication, and how failures can be avoided through modern fabricating techniques and expert workmanship are also discussed. This book is recommended for use by engineers in operating, research, and designed division.

Your copy may be obtained now. Simply

Circle E14 on Postcard

Stationary and motion control "vari-pitch" sheaves for speed variations up to 76 percent by means of pitch diameter adjustment are described in a new bulletin just released by Allis-Chalmers Manufacturing Company.

Included in the bulletin is a table of sizes and general dimensions of "vari-pitch" sheaves and a table of general dimensions for "Paraline" ball bearing motor bases, which are designed for use with the motion control "vari-pitch" sheaves.

Your copy of this informative bulletin is available now . . .

Circle E15 on Postcard

"How to Solve Piping Flexibility Problems" is the title of a new 8-page bulletin just published by Marco Manufacturing Company.

One section of this new bulletin shows Barco Swing Joints and Barco Flexible Ball Joints as used in tank truck loading and unloading lines. For the refinery experiencing difficulty in handling hot asphalt, Barco shows several ways to solve the problem. Details are also given on Barco steam-jacket Ball Joints.

Also included in this new bulletin are installation photos and information on Barco Flexible Strut Joints for refinery towers, stacks and large piping.

Design engineers, as well as operating engineers in plant and field installations, will find this new bulletin of particular interest.

To receive your copy, just . . .

Circle E16 on Postcard

Dry type transformers are described in a new bulletin recently released by the Standard Transformer Company.

The bulletin gives complete data on Standard Type MC and Type MCT, which are designed for use in hazardous and non-hazardous locations. These transformers are completely compound-filled and equipped with all-welded cases for indoor or outdoor use. They are normally fitted for wall mounting.

For your copy simply . . . .

Circle E17 on Postcard

Packaged Air Power is the subject of a new eight-page, two-color brochure recently released by Ingersoll Rand. This informative bulletin emphasizes the 3R-36 CFM self contained spot-air portable compressor. It also deals at length with the many tools it will operate. Actual on the job illustrations clearly point out the added advantages of this light weight compressor on jobs where bigger compressors are not needed.

Your copy of this bulletin, Form 2302, is available now. Simply . . .

Circle E18 on Postcard

Gas testing equipment is featured in a new bulletin now available from Rockwell Manufacturing Company. The company's complete line of gas testing equipment including bell provers, flow provers, test meters, and flow indicating meters is described.

The bulletin includes detailed factory recommendations for proving meters at different rates of flow. Also described are Rockwell's Test Meters, which are large dial modifications of new standard Rockwell aluminum domestic and commercial meters.

To receive your copy of this Bulletin, No. 1066-5, just . . . .

Circle E19 on Postcard

Centrifugal Air Washers for dust collection are described in a new bulletin prepared by The Ducon Company. The bulletin illustrates the Ducon principle of Centrifugal Air Washers which has been employed many times for the control of carbon black and many other fines.

The information contained in this bulletin will be of specific interest to those engaged in the recovery of fines.

Your copy of this bulletin is available now. Just . . .

Circle E20 on Postcard

Centrifugal Pumps for Acids, Alkalies, and Slurries are featured in a new bulletin just released by Worthington Corporation.

This new 20-page bulletin includes information and an outline drawing of Worthite pumps with standard stuffing box; photographs of typical open type impellers; parts list and a diagram of standard mechanical seal, and complete information on application and construction modifications.

Seven pages of rating charts show hydraulic coverage for both 50 and 60 cycle speeds.

Dimensions and drawings on bare pumps and pumps with base and motor are presented along with charts, parts lists, and cutaway views showing typical sections.

To receive your copy of this most informative bulletin, just . . . .

Circle E21 on Postcard

A cooling control which holds temperature of cooling water in jackets or coils of equipment such as compressors, oil coolers, condensers, and stills is featured in a new bulletin recently released by Sarco Company, Inc.

Called T44, this new control which costs less than $40.00 is adjustable between the ranges of 40 - 200° F. and is fully modulating. The standard model comes equipped with a single seated valve which is suitable for use with water containing scale forming minerals.

For your copy of this bulletin, Supplement 1, just . . .

Circle E22 on Postcard

Motor buying information is available in a new catalog published by General Electric Company.

Designated GEC-1026, this 28 page bulletin presents complete buying information on standard a-c fractional and integral horsepower motors in most general use. A special section on the selection of integral horsepower motors covers horsepower requirements, enclosures, starting current limitations, speeds, motor types, and selection of fuses and circuit breakers. Descriptions and specifications include single-phase, polyphase, totally enclosed fan cooled, and gear-type integral horsepower motors.

Information on all motors includes photos, ratings, book prices, dimensions, weights, frame numbers, and standard modifications.

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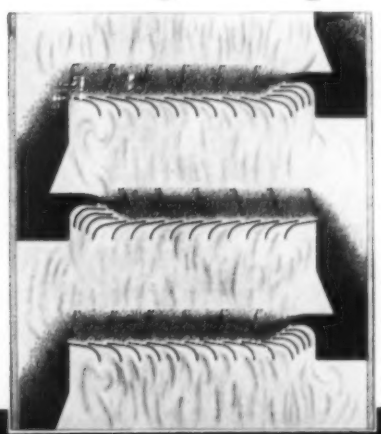
Photo courtesy of Oregon Game Commission

If high liquid volume is your problem



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One for Two

Modernization of the 4-B crude unit of Lion Oil Refining Company, El Dorado, Arkansas, called for a single fractionator to replace an old fractionator and an evaporator.

The vessel, 11 feet in diameter, 100 feet long, and equipped with 28 stainless steel trays, was fabricated in Wyatt's Dallas plant. It was the tallest and heaviest vessel ever installed by Lion's maintenance crews.

Along with carrying its double load, it has improved yields and efficiency.

Wyatt's
HOUSTON-DALLAS-NEW YORK-TULSA

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